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LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION

Public Health Service
Kansas City, Missouri

June 1950

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Federal Security Agency
Public Health Service
Division of Water Pollution Control
Missouri Drainage Basin
Kansas City, Missouri

June 1950

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LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION

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LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION

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INTRODUCTION

Plans for development of the land and water resources of the Missouri River Basin contemplate the utilization of water resources for maximum benefit to man. Water supply and sanitation are basic elements of any comprehensive program for water resource development. Proper consideration of water use for sanitation purposes requires information on present water quality, and the sources and amounts of pollution in the streams of the Basin under study. There has been apparent a vital need for the determination of the minimum stream flows essential for public water supply and sanitation purposes.

The Bureau of Reclamation, Department of Interior, being engaged in the development of a comprehensive plan for development of the water resources in the Lower Platte River Basin, believed it necessary that a basin-wide study of stream pollution be conducted to secure basic data for use in planning maximum water utilization, to document the extent and nature of existing pollution, and to record general standards of water quality. In a conference of February 24, 1949, State Health Officer W. S. Petty of Nebraska advised Regional Medical Director J. O. Dean, Region No. 7, Public Health Service, that a study of this type was beyond the resources of the State Health Department, and requested that such a study be undertaken by the Public Health Service with such assistance from the State Health Department as could be made available. After consultation with interested agencies, it was concluded that the Public Health Service, Federal Security Agency, would accept prime responsibility for this investigation, and in cooperation with the Nebraska State Health Department, would conduct a water pollution study. A Memorandum of Understanding between the Bureau of Reclamation and Public Health Service was prepared, and became effective March 29, 1949. The complete text of this Memorandum of Understanding is presented in appendix A.

A final report of the Lower Platte River Basin, as represented by this document, is specified in the Memorandum of Understanding.

In accordance with the text of the Memorandum of Understanding, the investigation on the Lower Platte River Basin included, among other things: (a) the extent, types and major sources of pollution; (b) a review of existing laws and pending legislation regarding pollution of public waters in the State of Nebraska; (c) information regarding the bacteriological quality of water at present and proposed diversion points and in existing irrigation canals; (d) minimum stream flows below the reservoirs necessary for water supply and sanitation purposes with present and contemplated pollution; (e) quality of water for municipal and other public uses; (f) possible benefits to pollution abatement by reservoir releases; and, (g) existing plans and further recommendations for pollution abatement.

The Missouri Drainage Basin Office of the Public Health Service initiated development of the water pollution investigation of the Lower Platte River Basin in March 1949. Early in April 1949 an engineer from the Nebraska State Health Department and an engineer from the Public Health Service were assigned to start field work and engineering investigations. Collection and examination of stream samples began April 25, 1949, by laboratory personnel furnished by the Public Health Service and the Nebraska State Health Department, and sample collectors from the Nebraska State Health Department. A total of three laboratories were in operation at the time of maximum activity. Field work was completed late in July 1949.

Development of this report has been carried on in close cooperation with the Nebraska State Health Department, and in accordance with the factors detailed in the Memorandum of Understanding. The first section deals with general water pollution problems in the Lower Platte River Basin and includes a review of State water pollution laws, information on pollution abatement program and plans, and a summary of recommendations and conclusions. The major sub-basins are presented individually in detail in separate sections of the report. Special studies, all laboratory and flow data, and other pertinent information are presented as appendices.

ACKNOWLEDGMENT

This study was conducted with the full support and cooperation of the Nebraska State Health Department represented by Dr. W. S. Petty, State Health Officer; T. A. Filipi, Director, Division of Sanitation, and R. M. Babcock, Public Health Engineer. Much essential information and other assistance was provided by the Lower Platte River Area office of the Bureau of Reclamation, particularly by Area Engineer Paul L. Harley and Hydraulic Engineer John Mayne. Drafting assistance for development of the report was also provided by the Bureau of Reclamation. Stream discharge data were secured through the close cooperation of District Engineer Douglas D. Lewis, Lincoln Office, U. S. Geological Survey, and Dan S. Jones, State Engineer of the Bureau of Irrigation, Water Power and Drainage.

Studies of the Fish and Wildlife Service were used in the preparation of this report.

Technical reviews of this report by the Environmental Health Center, Cincinnati, Ohio, and by the Division of Water Pollution Control, Washington, D. C., have been most helpful.

It is not possible nor practicable to indicate the assistance of all contributors; however this opportunity is taken to gratefully acknowledge the help and excellent cooperation shown by all connected with the Lower Platte River Water Pollution Investigation.

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SUMMARY

The Lower Platte River Basin is contained entirely within the State of Nebraska. East of the City of North Platte, the North and South Platte Rivers form the Platte River which flows eastward 310 miles to its confluence with the Missouri River near Plattsmouth, Nebraska. Rainfall averages about 28 inches in the eastern section of the Basin and decreases uniformly to about 18 inches in the western portion. Agriculture and related industries form the basis of the Basin's economy.

Irrigation has been practiced in the Basin since the latter part of the nineteenth century. The comprehensive plan of development for the maximum utilization of water resources in the Basin, as formulated by the Bureau of Reclamation, contemplates extension of irrigation, development of hydroelectric power, consideration of recreation, fish and wildlife, and public health and sanitation. Sixteen reservoirs and 19 major diversion dams are included in the comprehensive program.

In general, an adequate supply of ground water is available for municipal use. One hundred and forty-six communities serve a total population of 257,560 with water from wells, while one community serves 2,600 people with water from a surface supply.

All major streams and most tributaries receive pollution from both domestic and industrial wastes. Seventy-one communities discharge wastes to streams equivalent to a total population of 300,700. Public health hazards and nuisances, primarily of local consequence, result from the pollution and may be aggravated by low stream flows. The use of polluted waters for livestock watering and irrigation of low-growing crops, such as lettuce, celery, strawberries, cabbage, tomatoes and similar truck crops which are consumed raw should be viewed with caution. A minimum of primary sewage treatment should be provided by all communities with a higher degree of treatment where warranted. These needs have been itemized elsewhere in this report. A suggested program for State action toward a comprehensive program of water pollution control is presented, including steps to forward adequate State law and recommendations for sufficient personnel.

Flow-routing and regulation as proposed by the Bureau of Reclamation will affect stream discharges. Minimum desirable stream flows at pertinent locations have been specified and discharge regulations relative to the development program should, if possible, provide these needs. Cost benefits and damages have been provided where the proposed flows under the development program will alter the degree of waste treatment required.

CONCLUSIONS

1. The development program for maximum beneficial use of water resources as proposed by the Bureau of Reclamation will affect flows and those matters of public health and sanitation dependent upon adequate stream flows. Sixteen potential reservoirs and 19 diversion dams with various incidental improvements are considered a part of the comprehensive program.

2. Public water supplies will not be greatly affected by the development program as all but one community utilize an excellent and generally adequate ground source. One hundred and forty-six municipalities serve 257,560 people from ground water sources and one surface supply serves 2,600 people.

3. Surface water resources receive pollution from numerous sources and public health hazards and local nuisances will occur if minimum flows are reduced below that required for this purpose. Seventy-one communities produce domestic and industrial wastes totaling 410,700 population equivalents. Sewage treatment reduces the organic pollution 27 percent with a resultant discharge to streams of 300,700 population squivalents.

4. New sewage treatment plants or improvements are needed at 52 municipalities in the Basin. These needs are specified in table 9, General Section, and discussed in detail in sub-basin sections.

5. The pollution control activity of the State Health Department has been commensurate with water use, financial support, and statutory backing. Implications of the development program indicate need for an active state-wide program for control and abatement of pollution with adequate funds and supporting legislation.

6. Desirable mean minimum monthly flows based on at least primary treatment and satisfactory stream conditions have been presented in the sub-basin sections in tables P-9, L-10, and E-9. Wherever possible, stream regulation should consider provisions for these minimum flows. When stream regulation provides desirable minimum flows which are in excess of normal minimum flows, a cost benefit will accrue to the construction project. Reduction of flows below desirable minimums result in damages where normal minimums exceed the regulated flow.

7. As exemplified in the Lower Platte River Basin Program of the Bureau of Reclamation, public health needs and sanitation should receive considerations in the planning stages of development programs.

RECOMMENDATIONS

It is recommended that:

1. The State of Nebraska take concerted action to secure adequate statutory support for the control of water pollution.

2. The State Health Department assign sufficient funds to permit the procurement of an adequate staff of sanitary engineers so that the comprehensive program of pollution control and abatement, including assistance and consultation to municipalities and industry, may be expanded to provide full State coverage.

3. Sewage treatment should be provided at once by the following communities:

- Lexington
- Gibbon
- Columbus
- Ashland
- Weston
- Louisville
- Cedar Rapids
- Beemer
- St. Edward
- North Platte
- Cozad
- Madison
- Schuyler
- Winside
- Wakefield
- Oakland
- St. Paul
- Loup City
- Ravenna
- Burwell
- Ord
- Spalding
- Pilger
- Albion
- Pierce
- Gothenburg
- Norfolk
- Silver Creek
- Dodge
- Wahoo
- Pender
- Dannebrog
- Fremont
- West Point
- Wisner
- Stanton
- Tilden
- Neligh
- Fullerton
- Scribner
- Genoa
- O'Neill
- Kearney
- Humphrey
- Newman Grove
- Wayne
- Lyons
- Atkinson

The degree and type of treatment cannot be fully determined in all instances because of the influence of the potential development plans of the Bureau of Reclamation. In some locations primary treatment will suffice and in other cases secondary treatment will be desirable. These factors have been discussed in the sub-basin sections.

4. The following communities improve existing primary sewage treatment plants to a secondary treatment type:

- Snyder
- Howells
- Leigh
- Clarkson

5. Secondary treatment facilities be improved at the following communities:

Broken Bow Lincoln

Grand Island, including treatment of seasonal industrial wastes (Grand Island has under construction a $350,000 addition to its existing secondary treatment plant).

6. Caution be exercised in the use of sewage-polluted irrigation waters on low-growing crops that may be consumed raw. Chlorination of sewage treatment plant effluents to control pathogenic organisms may be a consideration.

7. Wherever possible, the flow regulation program related to the comprehensive development plan provide at least the useful desirable minimum flows as specified in this report in tables P-9, L-10, and E-9.

LOWER PLATTE RIVER BASIN - GENERAL SECTION

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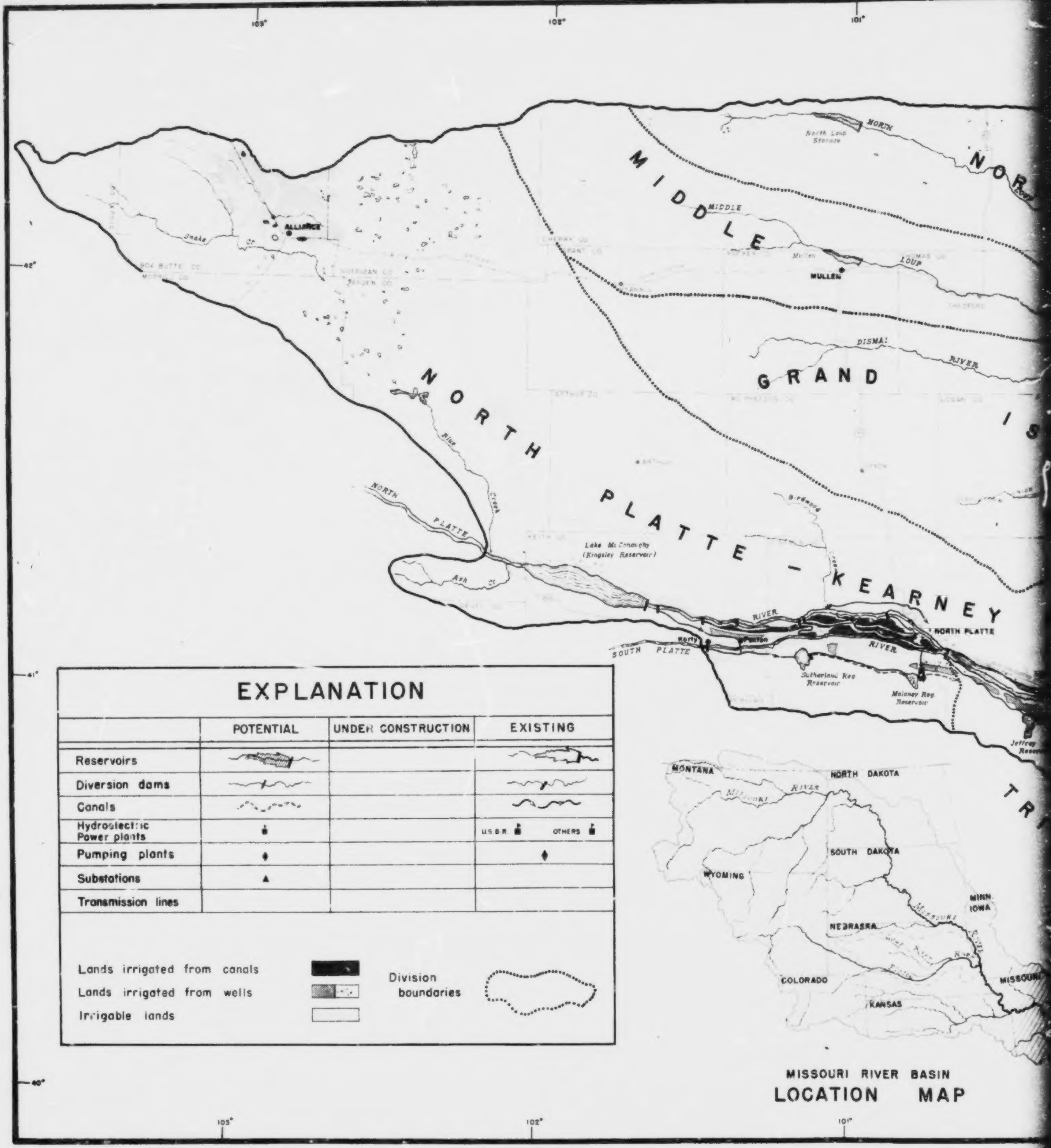
A


103°
102°
101°
42°
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MIDDLE
NORTH
NOR
GRAND
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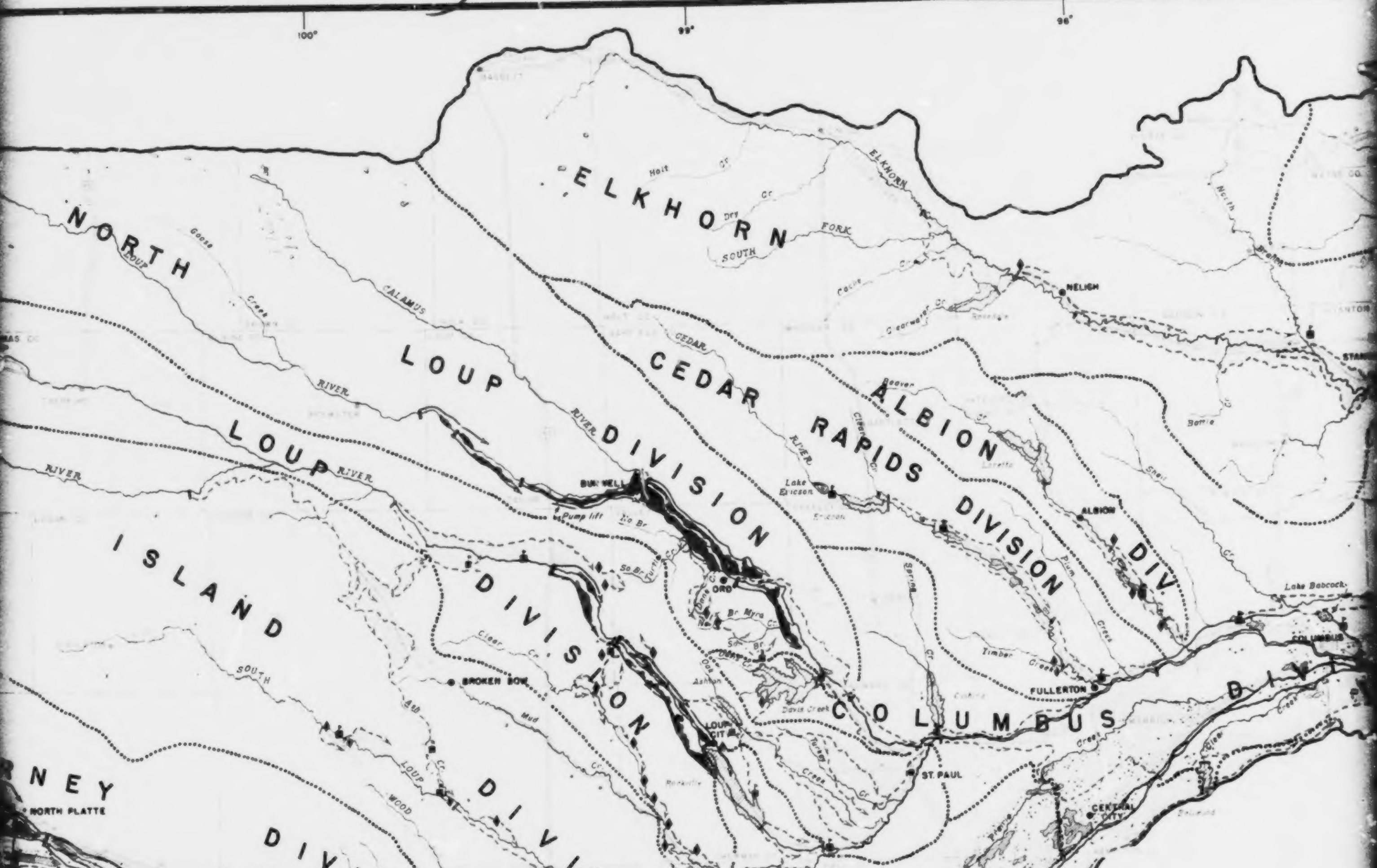
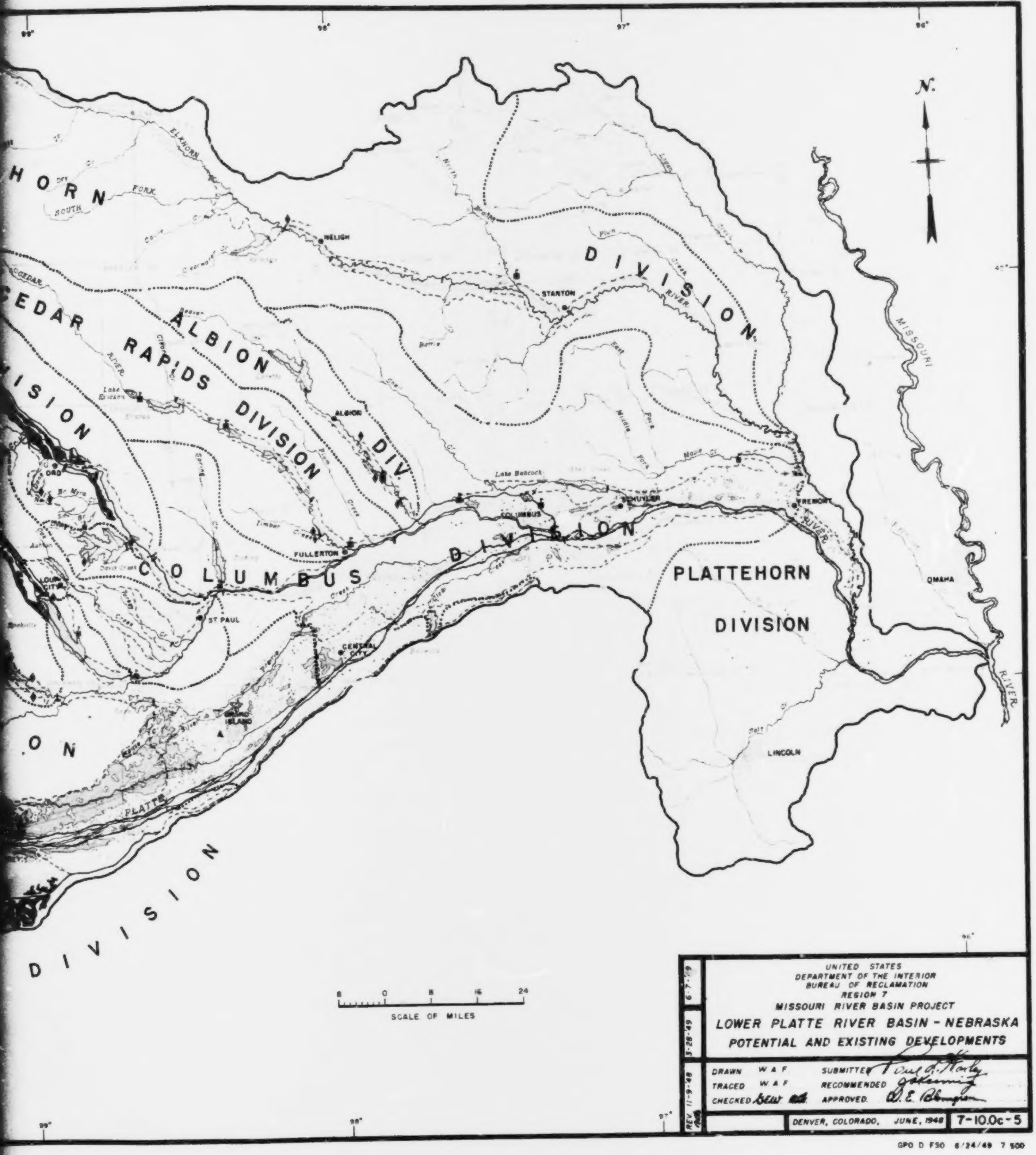
NORTH PLATTE - KEARNEY
TRI
North Loup Storage
MIDDLE
LOUP
Mullen
MULLEN
DISMAL
RIVER
ALLIANCE
Snake Cr.
BOX BUTTE CO.
MORRILL CO.
SHERIDAN CO.
GARDEN CO.
CHERRY CO.
GRANT CO.
THOMAS CO.
ARTHUR CO.
MC PHERSON CO.
LOGAN CO.
KEITH CO.
Blue Creek
NORTH PLATTE
Lake McConaughy (Kingsley Reservoir)
Ash Cr.
Birdwood Cr.
RIVER
SOUTH PLATTE
Korty
Paxton
Sutherland Reg. Reservoir
Maloney Reg. Reservoir
NORTH PLATTE
Jeffrey Reservoir
EXPLANATION
POTENTIAL
UNDER CONSTRUCTION
EXISTING
Reservoirs
Diversion dams
Canals
Hydroelectric Power plants
U.S.B.R.
OTHERS
Pumping plants
Substations
Transmission lines
Lands irrigated from canals
Lands irrigated from wells
Irrigable lands
Division boundaries
MONTANA
NORTH DAKOTA
Missouri River
SOUTH DAKOTA
WYOMING
MINN.
IOWA
NEBRASKA
Missouri River
Loup River
Platte
COLORADO
KANSAS
MISSOURI
MISSOURI RIVER BASIN
LOCATION MAP

13


100°
99°
98°
ELKHORN
NORTH LOUP DIVISION
CEDAR RAPIDS DIVISION
ALBION DIV
LOUP ISLAND DIVISION
DIVISION
COLUMBUS DIV
RNEY DIVISION
TRI - COUNTY DIVISION
NELIGH
STANTON
ALBION
Lake Babcock
COLUMBUS
FULLERTON
BURWELL
Pump lift
Lake Ericson
ORD
BROKEN BOW
LOUP CITY
ST. PAUL
CENTRAL CITY
GRAND ISLAND
KEARNEY
NORTH PLATTE
Jeffrey Reg Reservoir
Johnson Reg Reservoir
Plum Creek
PLATTE
CALAMUS
RIVER
SOUTH
LOUP
WOOD
MINN
IOWA
MISSOURI
8 0 8 16 24
SCALE OF MILES
BASIN
MAP

10-B

FIG. I



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 7
MISSOURI RIVER BASIN PROJECT

LOWER PLATTE RIVER BASIN - NEBRASKA
POTENTIAL AND EXISTING DEVELOPMENTS

DRAWN W.A.F.
TRACED W.A.F.
CHECKED
SUBMITTED
RECOMMENDED
APPROVED

REV. 11-9-48
3-28-49
6-7-49

DENVER, COLORADO, JUNE, 1948
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HISTORICAL BACKGROUND

Early maps of the Platte River carry the appellations "Nebraska River" or "Platte River", the former denoting an aboriginal name, and the latter a French translation. The Pawnees used the name "Kits Katus", or "Flat Water" for the Platte River, corresponding to the terms used by the Omaha and Oto tribes, "Ni Bthaska Ke" and "Ni Brathka", and having the same meaning. The Mallet brothers, French traders in Pawnee territory in 1739 near the present site of Kearney, Nebr., translated the Pawnee title to "La Riviere Plate", a name which has been perpetuated as the Platte River. Other names given by Spanish explorers were utilized until the massacre of the Spanish expedition led by Lt. General Villasur in 1720.

In 1803 the United States purchased the Louisiana Territory from France. The Territory containing 885,000 square miles extended from the Gulf of Mexico northward to British America, and from the Mississippi River westward to the Rocky Mountains. New explorations of the additional region began, and in 1843 a wave of emigration which aroused the Indians and astounded the officials of the Hudson Bay Company broke over the Oregon Trail. The Oregon Trail from Independence, Mo., led westward south of the Kansas River, crossing the river near the present site of Topeka, Kans.; thence up the Big and Little Blue Rivers, and cross country to the Platte near Grand Island, Nebr. The trail originally followed the south bank of the Platte River to North Platte, Nebr., and then to Fort Laramie, Wyo., where it was joined by the Mormon Trail. The latter began near Kanesville, Iowa, and followed the north bank of the Platte River until it merged with the Oregon Trail.

Fort Kearney, erected in 1846 as the first of a chain of forts on the Oregon Trail, was constructed for the protection of overland travelers against the Indians.

The Platte Basin was extensively populated with buffalo, fish and other wild life which served to sustain the Indian inhabitants. Fur trading encouraged early settlements; however agriculture has been important from an early date. As early as 1866 John Burke, an enterprising individual, irrigated his small farm to raise corn and vegetables which he sold to passing immigrants and soldiers at Fort McPherson. As agriculture further progressed, numerous towns came into being. Development has resulted in a rich agricultural area with supporting communities and industries.

PHYSICAL DESCRIPTION

Geography

The Lower Platte River Basin for the purpose of this report is defined as the area draining to the Platte River from Lake McConaughy (Kingsley Reservoir) on the west to its junction with the

Missouri River at Plattsmouth, Nebr. (fig. 1). The Basin is about 420 miles long, has a width varying from 90 to 155 miles near its west end to about 15 miles through the eastern third of its length below the mouth of the Elkhorn River. All of the area of 28,791 square miles is within the State of Nebraska.

Topography

The Lower Platte River Basin is a part of the Platte River Basin which is bound on the west by the crest of the Continental Divide. The North and South Platte Rivers which converge east of the City of North Platte originate in the mountain spurs of Wyoming and Colorado. These spurs blend into escarpments and lower ridges and becoms more imperceptible across the Plains section in Nebraska.

The snowfed headwaters of the Platte system follow tortuous stream beds, steep in gradient until they break out into the central Great Plains country. Elevations vary from about 6,000 feet at the base of the Rocky Mountains to 1,000 feet at the mouth of the Platte River. These plains, extending from the foothills of the Rockies across the major portion of the Lower Platte River Basin, are quite uniform and are characterized by broken rolling country with smooth slopes diminishing to the east, and by occasional flat ridges and eroded buttes to the west. West and central Nebraska north of the Platte River is part of the Great Sand Hills Country--an area characterized by dunes, generally from 20 to 60 feet in height, although some attain heights of several hundred feet. In this region exist hundreds of small lakes which are of importance to the economy of the region and tend to stabilize ground water levels and stream flows in the upper reaches of the Loup Rivers.

From the confluence of the North and South Platte Rivers, the Platte flows east in a broad, sandy, shallow bed for about 310 miles to its junction with the Missouri River. Throughout its length very little water is received from its south-side tributaries, almost all of the flow being contributed by the Loup and Elkhorn Rivers entering from the north. Most of the relatively constant discharge of the Loup and Elkhorn Rivers has its origin in the Sand Hills area of the Basin and is supplemented by runoff from the loess soils sections in the eastern one-third of Nebraska. Table 1 lists the principal tributaries of the Platte River.

Table 1. Lower Platte River Basin - Principal tributaries and their drainage areas.

Stream	Miles above mouth Platte River	Drainage Area[1] (Square miles)
Platte River		90,200
Main Platte River	0.0	28,791
Elkhorn River	33.4	6,800
Loup River	103.0	14,427
North Platte River	309.0	37,379
South Platte River	309.0	24,030

[1] Data from Platte River Report House Document 197, 73rd Congress, 2nd Session. Corps of Engineers bulletin.

Geological formations in the Basin consist of the Pleistocene Sand Hills in the north-central section and the extensive exposures of loess that occupy most of the eastern one-third of Nebraska. This loess is underlain in places by a fine mantle of glacial drift.

Climate

Wide ranges in climatic conditions prevail throughout the Basin. These vary from humid to subhumid near the Missouri River, and from semiarid in the central part of the State to arid in the western portion. Precipitation at the Missouri River amounts to about 28 inches, decreasing gradually to about 18 inches in the western part of the State. This variation in rainfall throughout the State is remarkably uniform, averaging about 1 inch decrease in precipitation from east to west for each 25 miles in distance. The major portion of the rainfall occurs in the summer when it is needed most. The annual precipitation varies considerably from year to year with a tendency to wet or dry periods, some of which are of several years duration.

Monthly and annual temperatures are characterized by wide ranges; day temperatures may exceed 100° F. a few times a year and minima of 0° F., or lower may occur about 15 days each year. Lows of -30° to -40° F. have been recorded. A frost-free period of about 150 days extending from May to October constitutes the average crop growing season.

The Basin is subject to high winds of varying intensity, which tend to hasten evaporation and to weather and erode cultivated land. Wind velocities are generally constant, with March and April usually being the months most affected.

Hydrology

The Platte River's flow originates in the Rocky Mountain area where the snowfall occurs early. Melting snow reaches the Platte River to recharge stream flow until late May and early June. Some mountain peaks retain their snowcaps throughout the year. Heavy June rainfall causes high flow conditions and often results in flooding along some tributaries. Cessation of excessive rainfall together with diversion of water for irrigation and a period of high evaporation and transpiration results in greatly reduced and minimal stream flows. Likewise, diversion and storage for irrigation and hydroelectric power purposes on the North and South Platte Rivers in Wyoming and Colorado affect peak discharges on the Platte River.

Ground water fluctuations have been recognized. These undulations depend upon the utilization and recharge of subsurface waters. Seepage losses from the water table account for some stream flow; conversely, surface flow recharges the ground water table through the sandy bed of the Platte River. All water resources are accredited with having made possible the present agricultural and industrial economy of the Basin.

ECONOMIC DEVELOPMENT

Agriculture and related activities form the basis of the economy of the region. Data compiled from the 1940 census credits agriculture with 37.4 percent of the employed workers, which is more than double the next most populous industrial group. The principal farm income was derived from livestock and represented 47.5 percent of the total source of farm revenue. The "Rural Level of Living Index" was 119 as compared to a national level of 101.

Vast grazing fields with an ample supply of water, coupled with accessibility of ready markets, combine to make livestock production highly significant. Wheat and corn have high dollar values while sugar beets, potatoes, alfalfa and other forage crops are lesser in importance. Related industries such as food-processing plants, flour mills, creameries, egg-packing, sugar beet refining, poultry dressing, and alfalfa dehydration plants are situated throughout the Basin.

From the early days of the Nebraska-Kansas territory transportation facilities have been under heavy demand. Several important railroads provide through transportation to the east and west coasts. Hard-surfaced highways serve the Basin and market roads are numerous.

Growth of population within the Basin was steady until the decade 1920-1930, when minor reductions in rural areas took place because of a general economic depression concurrent with a period of abnormally low precipitation which made farming a risk. Migration was largely to areas where agricultural pursuits had been stabilized through use of irrigation. Where irrigation had been practiced within Nebraska the population remained static or showed an increase. The U. S. Census recorded a decrease of 4.5 percent in population from 1930 to 1940 for the State of Nebraska. In 1940 there were 520,540 people residing in the Basin, of which 66 percent lived in rural areas.

USES OF WATER RESOURCES

Municipal Use

Water Supply - Throughout the Lower Platte River Basin municipalities, with the exception of Ord, which obtains its supply from the North Loup River, utilize ground sources for water supply. Most wells show good yields. In the smaller communities the use of individual wells continues.

The average per capita water consumption in this Basin exceeds 100 gallons a day normally expected in most communities. The availability of an adequate acceptable supply is reflected in the increased demand for lawn and garden watering due to the relatively dry climate and the increased use of water for air conditioning. Water use in some communities may approach 400 gallons each day per capita. Table 7 presents a summary of data for municipal water supplies by sub-basins.

The quality of well water is generally good; however treatment for manganese and iron is sometimes required. Chlorination is infrequently resorted to in periods of high rainfall when surface waters may reach the "zone of saturation" and pollute underground sources of supply.

Ord, the only municipality within the Basin which utilizes a surface supply, provides treatment consisting of aeration, prechlorination, coagulation, sedimentation, and filtration. Postchlorination is used to alleviate taste and odor conditions when the diversion dam site below Burwell is cleaned.

Sanitation

The use of streams for sanitary purposes is increasing in importance. Normally streams serve to drain adjacent land areas, and communities situated in reasonable proximity to water courses depend upon them to transport and dispose of wastes originating at communal sources of pollution. As most of the communities in the Basin utilize natural water courses for final sewage disposal, it is entirely proper to acknowledge the tremendous economic value due to such functions of this resource.

Admittedly the discharge of raw sewage, industrial wastes and other waste effluents without treatment invariably constitutes a misuse and may result in the debasement of receiving streams. However, ability of streams to successfully accept reasonable amounts of pollutants without detriment to other water uses, without insanitary conditions, or without nuisance is an asset that should be fully exploited. It is recognized that an economical degree of sewage treatment is based upon the dilution of the treated effluent by the stream and the recovery phenomenon occurring in moving bodies of water.

In the Lower Platte River Basin water supplies are usually derived from ground sources, and stream use for ultimate waste disposal ranks high among the functions of water resources. Sources of pollution are summarized by sub-basins in table 7.

Industrial Use

Industrial uses of water include processing, cooling, washing, and air conditioning. Large amounts of water are utilized in food processing industries such as dairies, meat packing, and poultry dressing plants. Meat packing plants may use 6,000 gallons of water per ton of animals processed, and poultry dressing establishments may consume 2,000 gallons for each 1,000 pounds live weight of birds handled. Its use for air conditioning is attaining widespread application in hotels, eating places, commercial establishments, and to a limited extent in private dwellings. The growth of industry within the Lower Platte River Basin has created an increased demand for adequate water supplies and this trend may be expected to continue with the anticipated expansion of industrial activity associated with the development of additional irrigation.

Irrigation

Early settlers who immigrated to the western regions of the Lower Platte River Basin soon discovered the speculation involved in dry-land farming. Irrigation dates back to 1866, and soon thereafter was recognized as an essential factor in the development of agriculture. Canals were constructed in the 1890's between Kearney on the Platte River and Keystone on the North Platte River. Irrigation works consisting of diversion and distribution projects were so constructed as to use the normal flow of the river. The tempo of construction was increased, particularly in the period 1891-1895, because of the attempt to organize and introduce legislation dealing with water rights and because of the severe drought which occurred in 1894-1895.

Prior to the construction of Pathfinder (1908) and Guernsey (1927) reservoirs in Wyoming, the nonseasonal flow was lost to downstream consumers. These installations had a stabilizing effect upon stream flow and led to the rehabilitation of such irrigation structures as the Six Mile, Orchard and Alfalfa, Cozad and Dawson County Canals.

The drought periods of the early thirties caused a great demand for adequate water storage by irrigators along the Platte River. After the completion of negotiations for the use of the conserved water, a construction organization began work upon the Sutherland system in August 1934, the facilities of which were ready for operation in December 1935 and included a storage reservoir and distribution canals. This system has since received some of the Lake McConaughy discharge, the latter being completed in 1938, to serve about 70,000 acres of land. The complexity of irrigation development is illustrated in figure 2 showing canal and stream locations.

The use of well irrigation had its beginning before 1926. This method received its great impetus in the 1930s when the severe drought forced irrigators to resort to pumping from the ground reservoir and nearly 20 years later about 40 percent of the irrigated land was serviced in this manner (table 2). About 175,000 acres were serviced by more than 4,000 wells. This increased utilization of well irrigation has resulted in a drop of the ground water level in some areas, and many irrigators are of the opinion that continued expansion will result in a further declination of the ground water thereby leading to increased pumping costs. It is important to note further that despite favorable moisture conditions since 1941, well irrigation has grown and it is likely that a sizeable increase would accompany a drought as severe as that of the 1930s.

Present irrigation methods serve about 25 percent of the potential arable area. Most of the land served by gravity irrigation lies in the Platte Valley; the remainder is located in the North and Middle Loup Valleys. Well irrigation has been utilized throughout the Platte River Valley, particularly in the regions between Central City and Gothenburg. Both gravity and well servicing methods, dependent upon the available water, are resorted to in farming areas west of Kearney. East of Kearney ground water elevations have declined despite recharge from the Platte River. Observers have noted that the rate of recharge has not met crop requirements, thereby resulting in an appreciable loss in the underground reservoir. Present ground water supplies required for developments in the North and Middle Loup as well as the Elkhorn irrigation systems, are also recognized as insufficient.

The Bureau of Reclamation in the Lower Platte River Basin Comprehensive Plan[1] considers a total of 2,165,800 acres to be serviced, of which 444,600 acres were serviced in 1946 by gravity and well supplies (table 2). The ramifications of this comprehensive program are depicted diagrammatically in figure 3.

Crop productivity and animal units recorded in the Basin and in Scotts Bluff County during the period 1929-1944 are compared with

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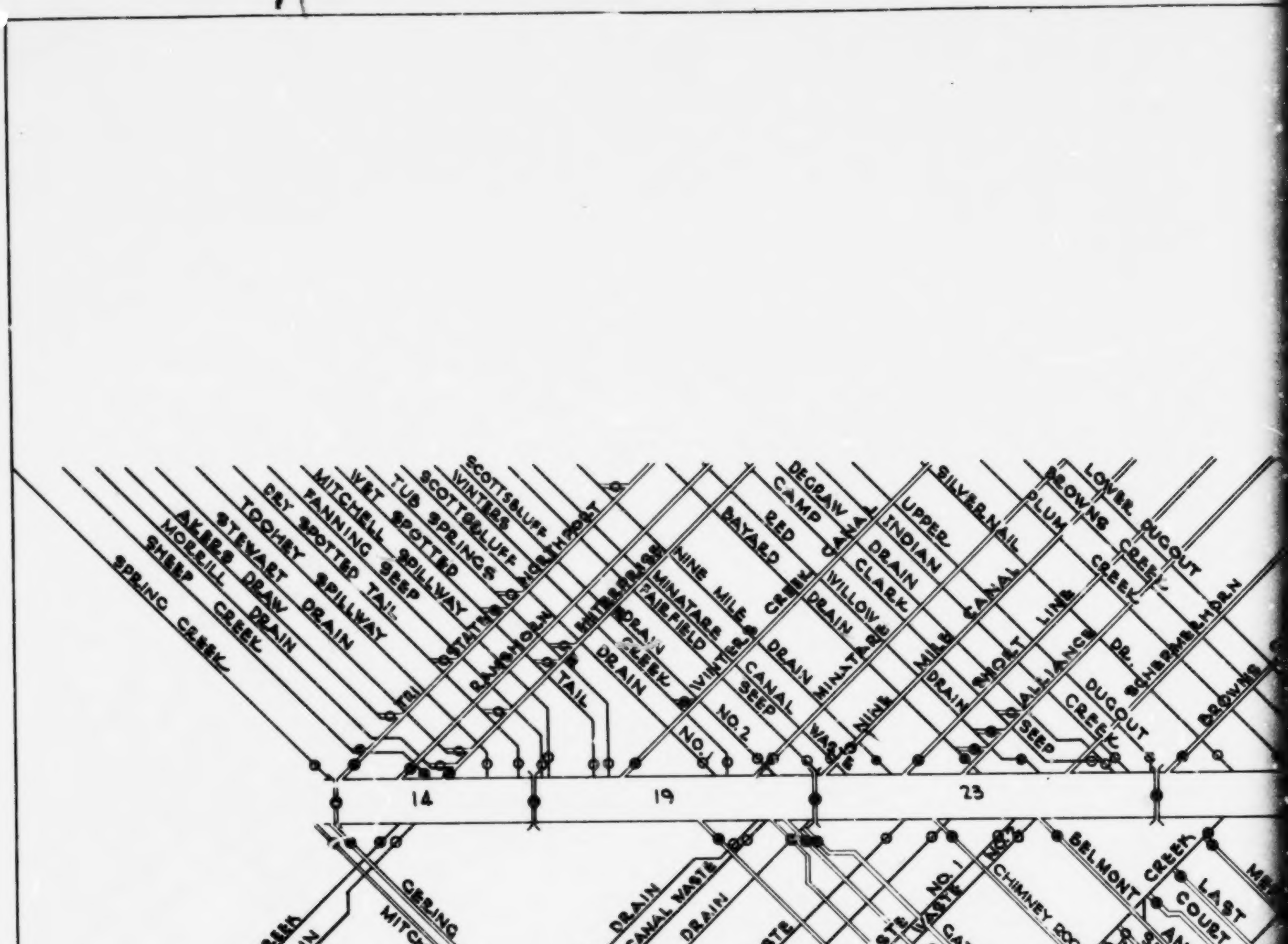
[1] Bureau of Reclamation - Lower Platte River Basin, April 1950

Table 2. Lower Platte River Basin - Irrigated areas - existing and potential[1]

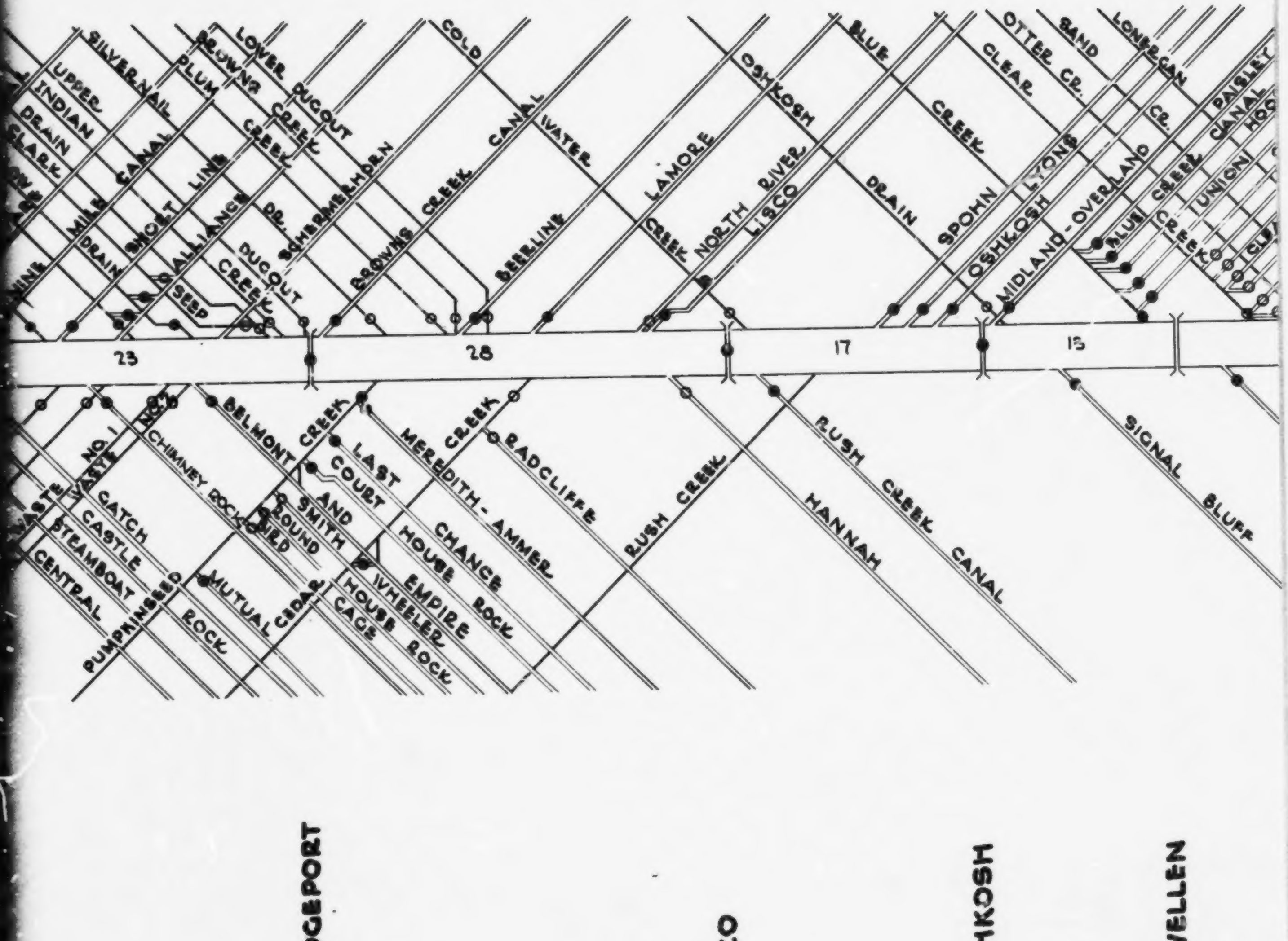
Division	Acres Irrigated (1946)		Irrigation Investigations			
	Gravity	Well or Pumps	Irrigated	Irrigable	Total	Deferred
North Platte-Kearney	143,041	37,338	180,379	190,414	370,793	0
Tri-County	65,180	17,483	82,663	165,183	247,846	28,735
Grand Island	0	93,559	93,559	294,279	387,838	0
Middle Loup	9,215	2,551	11,766	87,630	99,396	0
North Loup	25,515	1,447	26,962	24,305	51,267	0
Columbus	0	17,567	17,567	390,395	407,962	40,100
Cedar Rapids	0	2,865	2,865	19,370	22,235	1,196
Albion	0	1,761	1,761	15,934	17,695	0
Elkhorn	0	0	0	54,700	54,700	6,387
Plattehorn	0	541	541	31,159	31,700	19,029
Total	242,951	175,112	418,063	1,273,369	1,691,432	95,447

[1] Data from Bureau of Reclamation

A


SCOTTSBLUFF
WINTERS
SCOTTSBLUFF
WET TUB SPRINGS
MITCHELL SPOTTED
FANNING SPILLWAY
DRY SPOTTED TAIL
TOOHEY SPILLWAY
STEWART DRAIN
AKERS DRAW
MORRILL DRAIN
SHEEP CREEK
SPRING CREEK
TRI STATE
NORTHPORT
RAMSHORN
WINTERCREEK
TAIL
DRAIN
CREEK
DRAIN
NINE MILE
MINATARE
FAIRFIELD
WINTER
CANAL
SEEP
NO. 2
NO. 1
DEGRAW
CAMP
RED
BAYARD
CREEK
DRAIN
WILLOW
CLARK
INDIAN
UPPER
DRAIN
MINATARE
WASTE
NINE MILE
DRAIN
CANAL
SILVERNAIL
PLUM
SHORT LINE
ALLIANCE DR.
SEEP
LOWER DUGOUT
BROWNS CREEK
CREEK
DUGOUT CREEK
SCHERMERHORN
BROWNS
14
19
23
HORSE CREEK
LANE DRAIN
GERING
MITCHELL
GERING DRAIN
CENTRAL CANAL WASTE
MELBETA DRAIN
CASTLE ROCK WASTE
CLEVELAND DRAIN
CHIMNEY ROCK
CHIMNEY ROCK
CENTRAL
WASTE
WASTE NO. 1
NO. 2
CATCH
CASTLE
STEAMBOAT
PUMPKINSEED
ROCK
MUTUAL
CHIMNEY ROCK
BELMONT
CREEK
LAST
COURT
AND
SMITH
ROUND
RED
CEDAR
CAGE
HOUSE
WHEEL
HOU
EM
ME
RO
WYO. NEBR. LINE
MITCHELL
MINATARE
BRIDGEPORT

SHOWING


SILVERNAIL
UPPER
INDIAN
DRAIN
CLARK
LOWER
BROWNS CREEK
PLUM
DUCOUT
CREEK
MILE
CANAL
SHORT LINE
ALLIANCE DR.
SCHERMERHORN
DRAIN
SEEP
DUCOUT CREEK
BROWNS CREEK CANAL
COLD
WATER
BEERLINE
LAMORE
CREEK
NORTH RIVER
LISCO
OSHKOSH
BLUE
CREEK
DRAIN
CLEAR
OTTER CR.
SAND
LONERGAN
CR.
SPOHN
LYONS
OSHKOSH
MIDLAND-OVERLAND
BLUE CREEK
CREEK
PAISLEY
CANAL
UNION
23
28
17
15
NO. 1
NO. 2
WASTE
WASTE
CHIMNEY ROCK
BELMONT
CREEK
LAST CHANCE
COURT HOUSE ROCK
MEREDITH-AMMER
CREEK
RADCLIFFE
CATCH
CASTLE
STEAMBOAT
CENTRAL
PUMPKINSEED
ROCK
MUTUAL
CEDAR
BIRD
ROUND
SMITH AND
WHEELER
EMPIRE
HOUSE ROCK
CAGE
RUSH CREEK
HANNAH
RUSH CREEK CANAL
SIGNAL BLUFF
BRIDGEPORT
LISCO
OSHKOSH
LEWELLEN

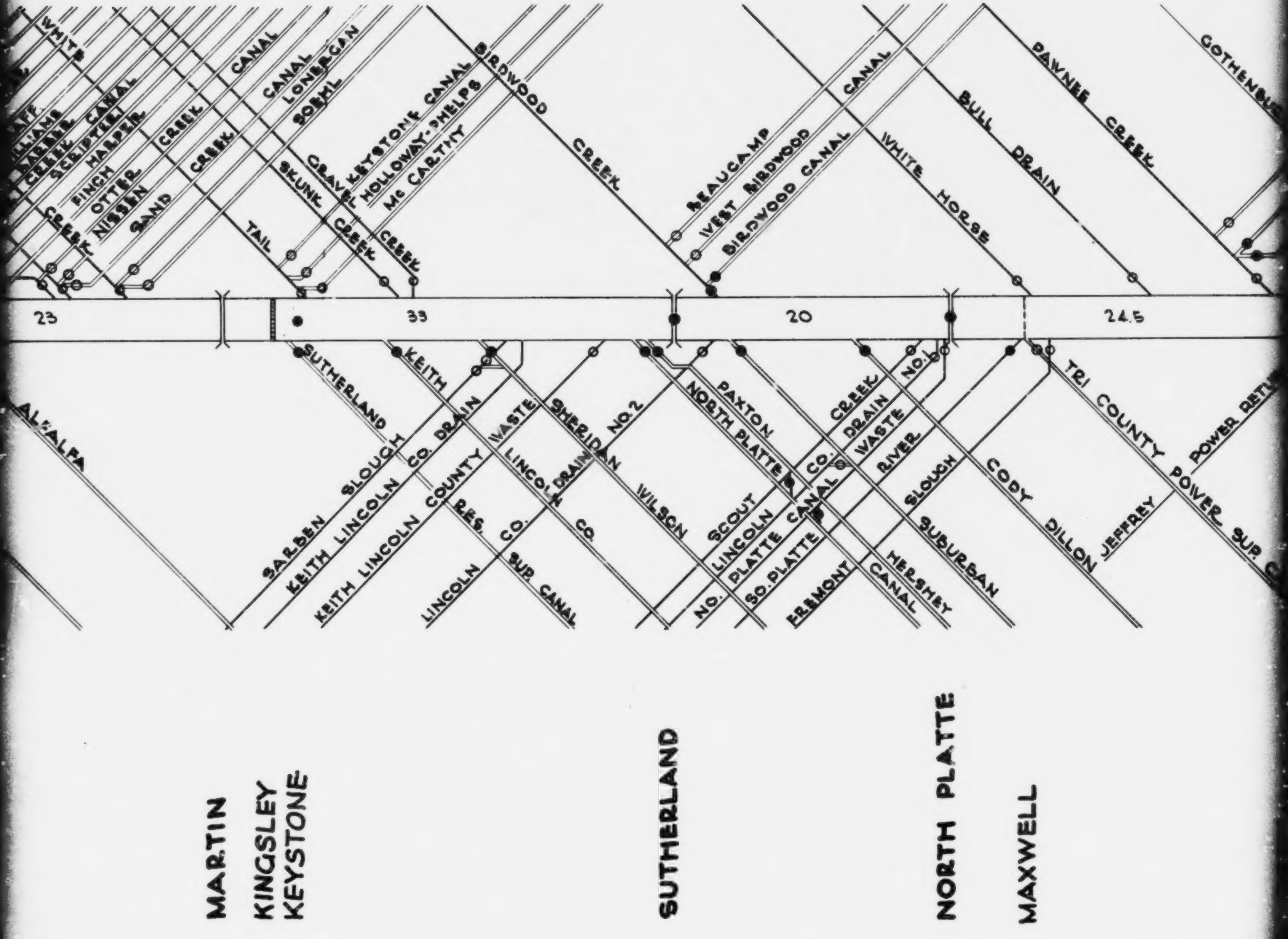
C

STATE OF NEBRASKA
DEPARTMENT OF ROADS AND IRRIGATION
BUREAU OF IRRIGATION WATER POWER AND DRAINAGE
FRED G. HERVERT OFFICE ENG'R R.H. WILLIS CHIEF

DIAGRAM
LOCATION OF CANALS AND STREAMS ON NORTH PLATTE AND PLATTE RIVERS FROM WYO.-NEBR. LINE TO KEARNEY

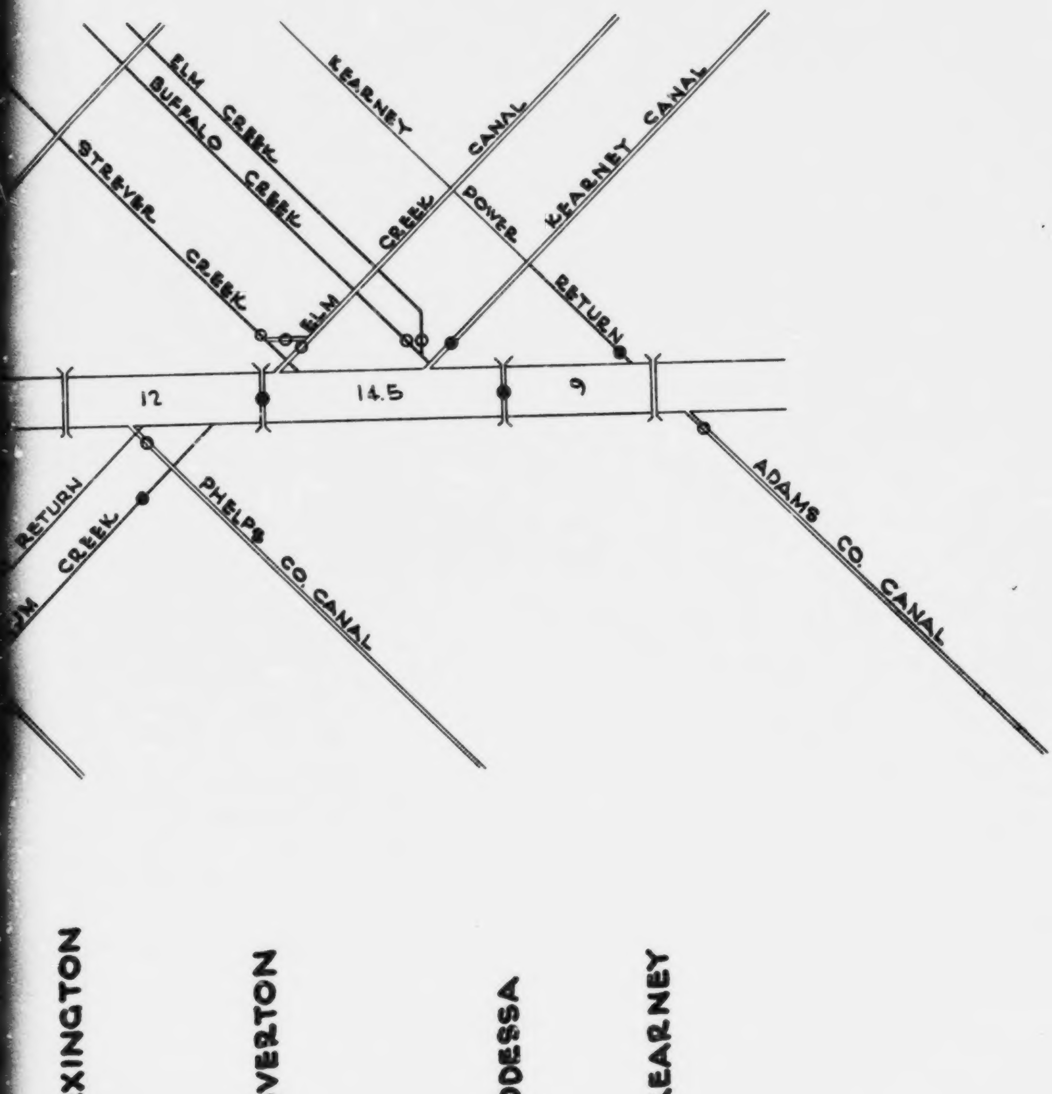
LEGEND

GAGING STATION
- Automatic Recorders ●
- Daily Observations ⊙
- Daily Obs. from May to Sept. inclusive ○

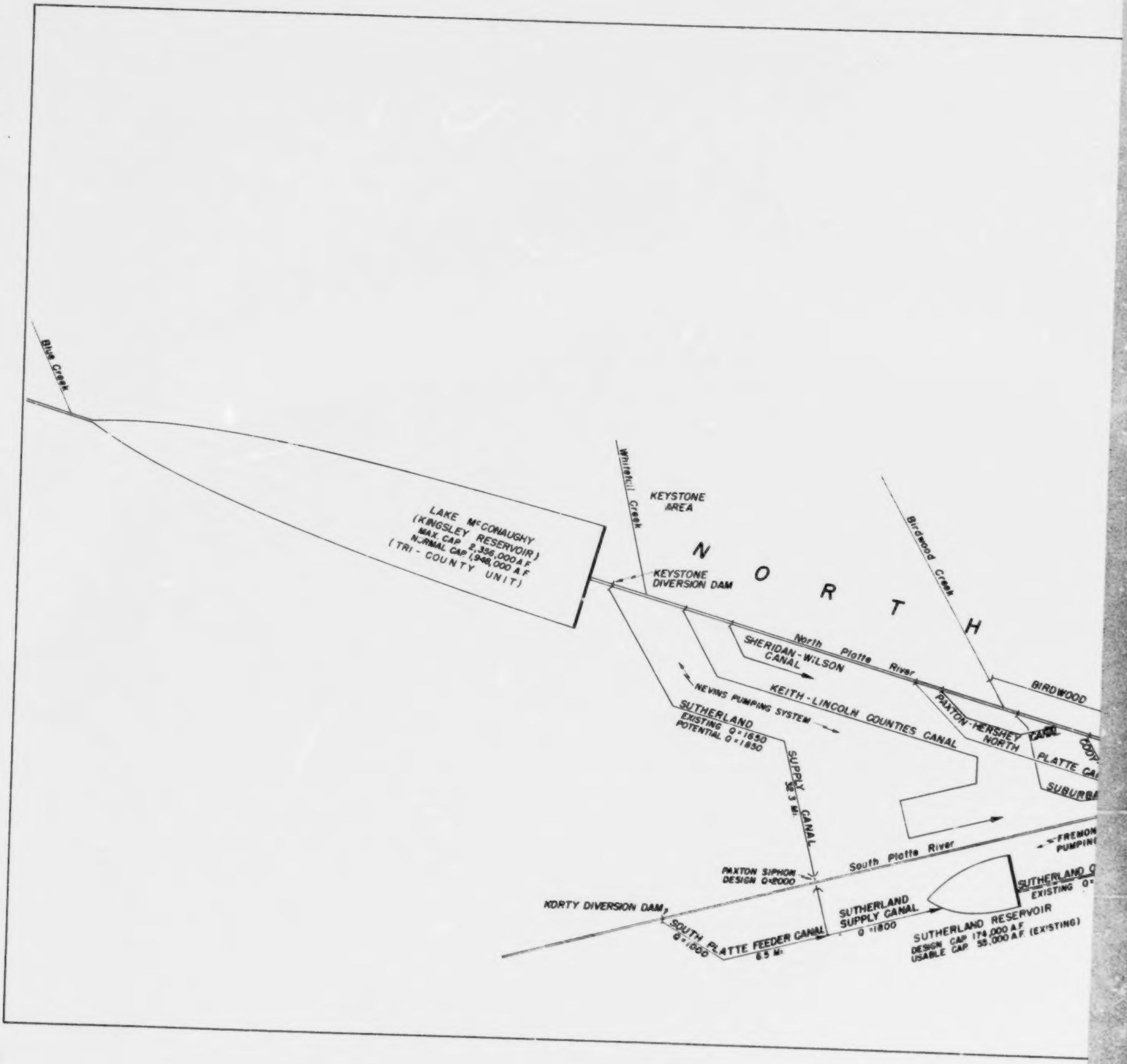


E

FIGURE 2.

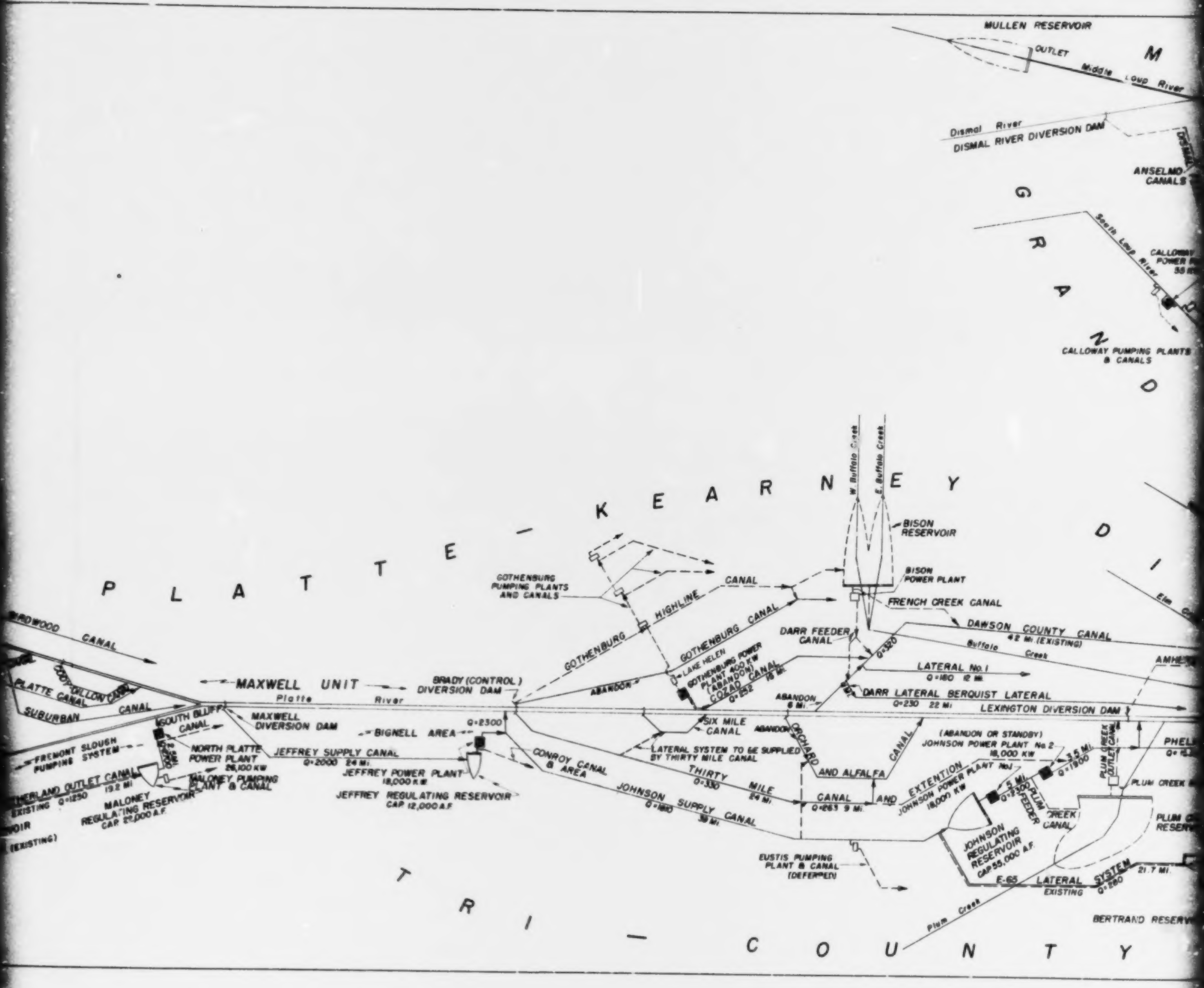

ELM CREEK
BUFFALO CREEK
KEARNEY POWER RETURN
ELM CREEK CANAL
KEARNEY CANAL
STREVER CREEK
ELM
12
14.5
9
RETURN
M CREEK
PHELPS CO. CANAL
ADAMS CO. CANAL
LEXINGTON
OVERTON
ODESSA
KEARNEY

A



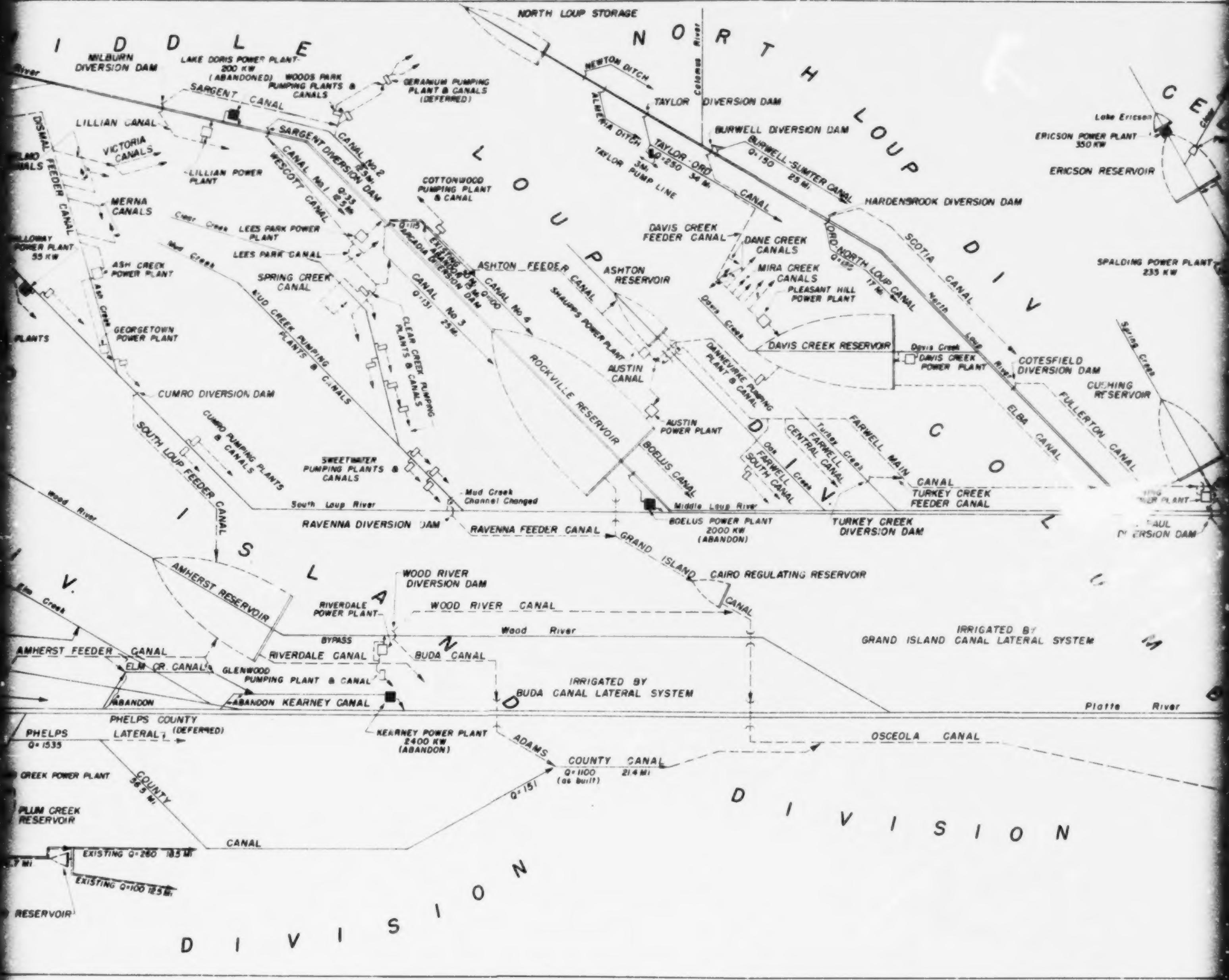
Blue Creek
LAKE McCONAUGHY
(KINGSLEY RESERVOIR)
MAX. CAP. 2,356,000 A.F.
NORMAL CAP. 1,948,000 A.F.
(TRI - COUNTY UNIT)
Whitetail Creek
KEYSTONE AREA
NORTH
KEYSTONE DIVERSION DAM
Birdwood Creek
North Platte River
SHERIDAN-WILSON CANAL
KEITH-LINCOLN COUNTIES CANAL
NEVINS PUMPING SYSTEM
SUTHERLAND
EXISTING Q=1650
POTENTIAL Q=1850
SUPPLY CANAL
32.3 MI.
PAXTON-HERSHEY
NORTH
PLATTE CA
BIRDWOOD
COOP
SUBURBA
FREMON
PUMPING
South Platte River
PAXTON SIPHON
DESIGN Q=2000
KORTY DIVERSION DAM
SOUTH PLATTE FEEDER CANAL
Q=1000
6.5 MI.
SUTHERLAND SUPPLY CANAL
Q=1800
SUTHERLAND RESERVOIR
DESIGN CAP 174,000 A.F.
USABLE CAP 55,000 A.F. (EXISTING)
SUTHERLAND C
EXISTING Q=

B


MULLEN RESERVOIR
OUTLET
Middle Loup River
M
Dismal River
DISMAL RIVER DIVERSION DAM
ANSELMO CANALS
G R A N D
South Loup River
CALLOWAY PUMPING PLANTS & CANALS
D I
Elm
W. Buffalo Creek
E. Buffalo Creek
BISON RESERVOIR
BISON POWER PLANT
P L A T T E – K E A R N E Y
GOTHENBURG PUMPING PLANTS AND CANALS
GOTHENBURG HIGHLINE CANAL
GOTHENBURG CANAL
LAKE HELEN
GOTHENBURG POWER PLANT 400 KW (ABANDON)
COZAD CANAL Q=252 18 Mi.
ABANDON
DARR FEEDER CANAL
Q=320
FRENCH CREEK CANAL
DAWSON COUNTY CANAL 42 Mi. (EXISTING)
Buffalo Creek
LATERAL No. 1 Q=180 12 Mi.
DARR LATERAL BERQUIST LATERAL Q=230 22 Mi.
ABANDON 6 Mi.
LEXINGTON DIVERSION DAM
AMHE
BIRDWOOD CANAL
PLATTE CANAL
DILLON CANAL
SUBURBAN CANAL
MAXWELL UNIT
Platte River
BRADY (CONTROL) DIVERSION DAM
SOUTH BLUFF CANAL
MAXWELL DIVERSION DAM
BIGNELL AREA
Q=2300
FREMONT SLOUGH PUMPING SYSTEM
NORTH PLATTE POWER PLANT 26,100 KW
JEFFREY SUPPLY CANAL Q=2000 24 Mi.
JEFFREY POWER PLANT 18,000 KW
JEFFREY REGULATING RESERVOIR CAP. 12,000 A.F.
THERLAND OUTLET CANAL EXISTING Q=1250 19.2 Mi.
MALONEY PUMPING PLANT & CANAL
MALONEY REGULATING RESERVOIR CAP. 22,000 A.F.
OIR (EXISTING)
SIX MILE CANAL
LATERAL SYSTEM TO BE SUPPLIED BY THIRTY MILE CANAL
CONROY CANAL & AREA
THIRTY MILE Q=330 24 Mi.
CANAL Q=263 9 Mi.
ORCHARD AND ALFALFA CANAL
AND EXTENTION
JOHNSON SUPPLY CANAL Q=1810 39 Mi.
(ABANDON OR STANDBY) JOHNSON POWER PLANT No. 2 18,000 KW
JOHNSON POWER PLANT No. 1 18,000 KW
3.5 Mi. Q=1900
5 Mi. Q=2300
PLUM FEEDER
CREEK CANAL
PLUM CREEK OUTLET CANAL
PLUM CREEK
PHEL
PLUM C RESERV
JOHNSON REGULATING RESERVOIR CAP. 55,000 A.F.
EUSTIS PUMPING PLANT & CANAL (DEFERRED)
E-65 LATERAL SYSTEM EXISTING Q=280
21.7 Mi.
BERTRAND RESERV
Plum Creek
T R I – C O U N T Y

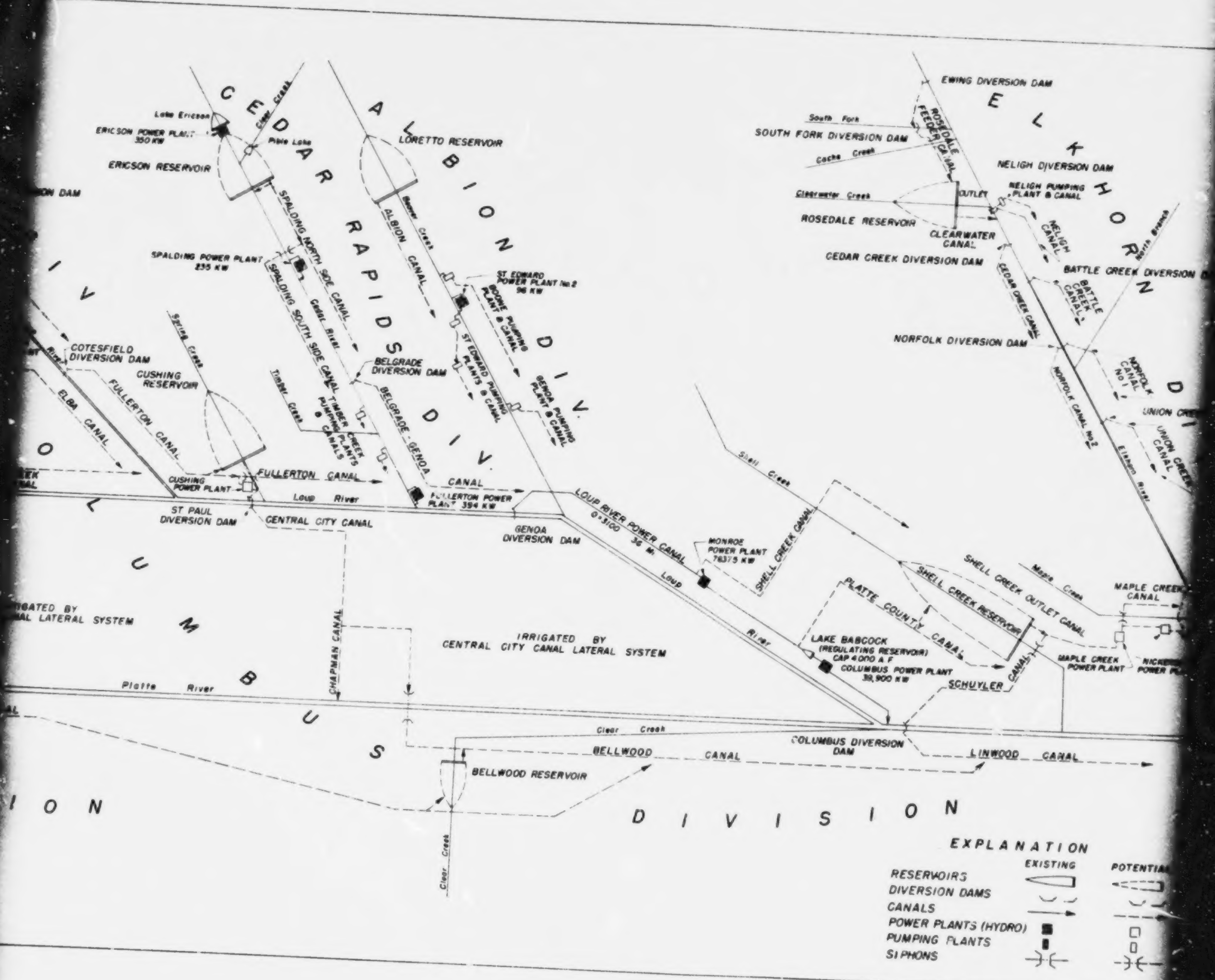
18-C

C



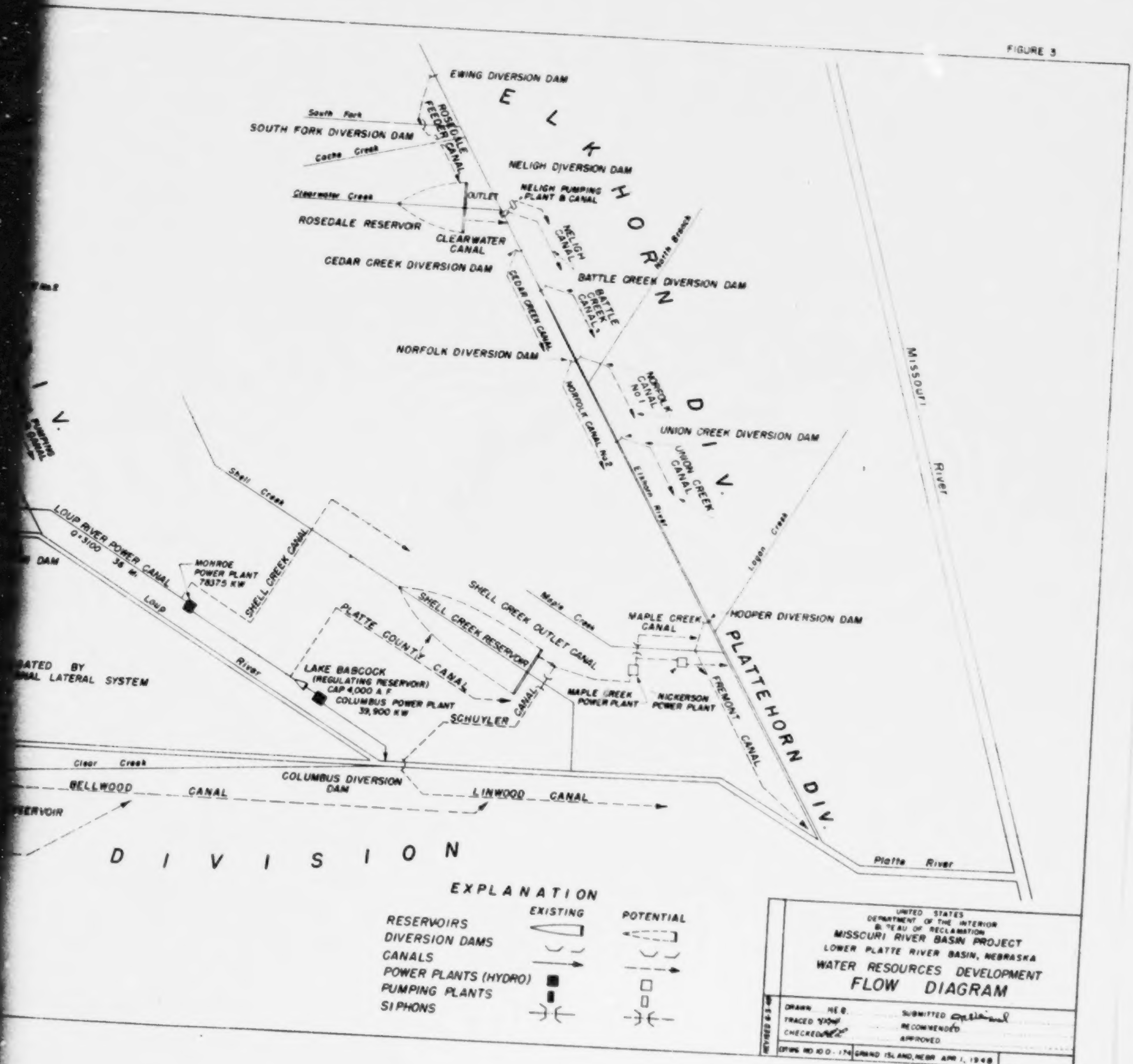
MIDDLE
NORTH LOUP DIV
LOUP DIV.
COLUMB
CEN
GRAND ISLAND DIVISION
DIVISION
NORTH LOUP STORAGE
NEWTON DITCH
Calamus River
TAYLOR DIVERSION DAM
ALMERIA DITCH
TAYLOR - ORD Q=250 34 Mi CANAL
TAYLOR PUMP LINE
BURWELL DIVERSION DAM
BURWELL-SUMTER CANAL Q=150 25 Mi
HARDENBROOK DIVERSION DAM
ORD-NORTH LOUP CANAL Q=180 17 Mi
SCOTIA CANAL
North Loup River
DAVIS CREEK FEEDER CANAL
DANE CREEK CANALS
MIRA CREEK CANALS
PLEASANT HILL POWER PLANT
Davis Creek
DAVIS CREEK RESERVOIR
DAVIS CREEK POWER PLANT
COTESFIELD DIVERSION DAM
ELBA CANAL
FULLERTON CANAL
CUSHING RESERVOIR
Spring Creek
Lake Ericson
ERICSON POWER PLANT 350 KW
ERICSON RESERVOIR
SPALDING POWER PLANT 235 KW
River
MILBURN DIVERSION DAM
LAKE DORIS POWER PLANT 200 KW (ABANDONED)
WOODS PARK PUMPING PLANTS & CANALS
GERANIUM PUMPING PLANT & CANALS (DEFERRED)
SARGENT CANAL
SARGENT DIVERSION DAM
CANAL No 2 8.5 Mi
CANAL No 1 Q=33 23 Mi
WESCOTT CANAL
LILLIAN CANAL
VICTORIA CANALS
LILLIAN POWER PLANT
DISMAL FEEDER CANAL
MERNA CANALS
CALLOWAY POWER PLANT 55 KW
ASH CREEK POWER PLANT
Ash Creek
Clear Creek
LEES PARK POWER PLANT
LEES PARK CANAL
Mud Creek
SPRING CREEK CANAL
MUD CREEK PUMPING PLANTS & CANALS
GEORGETOWN POWER PLANT
CUMRO DIVERSION DAM
CUMRO PUMPING PLANTS & CANALS
SOUTH LOUP FEEDER CANAL
COTTONWOOD PUMPING PLANT & CANAL
ARCADIA DIVERSION DAM
EXISTING CANAL Q=115
CANAL No 3 Q=151 25 Mi
CANAL No 4 Q=100
CLEAR CREEK PUMPING PLANTS & CANALS
ASHTON FEEDER CANAL
ASHTON RESERVOIR
SHAUPPS POWER PLANT
ROCKVILLE RESERVOIR
AUSTIN CANAL
AUSTIN POWER PLANT
BOELUS CANAL
DANNEVIRKE PUMPING PLANT & CANAL
FARWELL CENTRAL CANAL
FARWELL SOUTH CANAL
FARWELL MAIN CANAL
Turkey Creek
Oak Creek
TURKEY CREEK FEEDER CANAL
TURKEY CREEK DIVERSION DAM
POWER PLANT
PAUL DIVERSION DAM
SWEETWATER PUMPING PLANTS & CANALS
Mud Creek Channel Changed
South Loup River
Middle Loup River
BOELUS POWER PLANT 2000 KW (ABANDON)
RAVENNA DIVERSION DAM
RAVENNA FEEDER CANAL
GRAND ISLAND CANAL
CAIRO REGULATING RESERVOIR
Wood River
AMHERST RESERVOIR
Elm Creek
WOOD RIVER DIVERSION DAM
RIVERDALE POWER PLANT
WOOD RIVER CANAL
BYPASS
RIVERDALE CANAL
BUDA CANAL
AMHERST FEEDER CANAL
ELM CR. CANAL
GLENWOOD PUMPING PLANT & CANAL
ABANDON
ABANDON KEARNEY CANAL
IRRIGATED BY BUDA CANAL LATERAL SYSTEM
IRRIGATED BY GRAND ISLAND CANAL LATERAL SYSTEM
Platte River
PHELPS COUNTY LATERAL (DEFERRED)
PHELPS Q=1535
KEARNEY POWER PLANT 2400 KW (ABANDON)
ADAMS COUNTY CANAL Q=1100 (as built) 21.4 Mi
Q=151
OSCEOLA CANAL
CREEK POWER PLANT
COUNTY 56.5 Mi
CANAL
PLUM CREEK RESERVOIR
EXISTING Q=250 18.5 Mi
EXISTING Q=100 12.5 Mi
7 Mi
RESERVOIR

D


CEDAR RAPIDS DIV.
ALBION DIV.
ELKHORN DI
COLUMBUS DIVISION
Lake Ericson
ERICSON POWER PLANT 350 KW
Cedar Creek
Pibel Lake
ERICSON RESERVOIR
LORETTO RESERVOIR
Beaver Creek
ALBION CANAL
SPALDING POWER PLANT 235 KW
SPALDING NORTH SIDE CANAL
SPALDING SOUTH SIDE CANAL
Cedar River
ST EDWARD POWER PLANT No 2 96 KW
BOONE PUMPING PLANT & CANAL
ST EDWARD PUMPING PLANTS & CANAL
GENOA PUMPING PLANT & CANAL
BELGRADE DIVERSION DAM
BELGRADE - GENOA CANAL
TIMBER CREEK PUMPING PLANTS & CANALS
Timber Creek
Spring Creek
COTESFIELD DIVERSION DAM
CUSHING RESERVOIR
ELBA CANAL
FULLERTON CANAL
CUSHING POWER PLANT
FULLERTON CANAL
Loup River
FULLERTON POWER PLANT 394 KW
ST PAUL DIVERSION DAM
CENTRAL CITY CANAL
GENOA DIVERSION DAM
LOUP RIVER POWER CANAL
0+3100 36 Mi
MONROE POWER PLANT 78375 KW
Loup River
SHELL CREEK CANAL
Shell Creek
EWING DIVERSION DAM
South Fork
SOUTH FORK DIVERSION DAM
ROSEDALE FEEDER CANAL
Cache Creek
NELIGH DIVERSION DAM
NELIGH PUMPING PLANT & CANAL
Clearwater Creek
OUTLET
ROSEDALE RESERVOIR
CLEARWATER CANAL
NELIGH CANAL
North Branch
CEDAR CREEK DIVERSION DAM
CEDAR CREEK CANAL
BATTLE CREEK DIVERSION
BATTLE CREEK CANAL
NORFOLK DIVERSION DAM
NORFOLK CANAL No 1
NORFOLK CANAL No 2
UNION CANAL
Elkhorn River
IRRIGATED BY CENTRAL CITY CANAL LATERAL SYSTEM
CHAPMAN CANAL
Platte River
PLATTE COUNTY CANAL
SHELL CREEK RESERVOIR
SHELL CREEK OUTLET CANAL
Maple Creek
MAPLE CREEK CANAL
MAPLE CREEK POWER PLANT
LAKE BABCOCK (REGULATING RESERVOIR) CAP 4000 A F
COLUMBUS POWER PLANT 39,900 KW
SCHUYLER CANAL
Clear Creek
COLUMBUS DIVERSION DAM
BELLWOOD CANAL
LINWOOD CANAL
BELLWOOD RESERVOIR
Clear Creek
EXPLANATION
EXISTING
RESERVOIRS
DIVERSION DAMS
CANALS
POWER PLANTS (HYDRO)
PUMPING PLANTS
SIPHONS

E

FIGURE 3



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
LOWER PLATTE RIVER BASIN, NEBRASKA
WATER RESOURCES DEVELOPMENT
FLOW DIAGRAM

REVISED 6-9-48
DRAWN H.E.B. SUBMITTED
TRACED
CHECKED
RECOMMENDED
APPROVED
DRWG NO 10 D - 174 GRAND ISLAND, NEBR APR 1, 1948

precipitation in figure 4. In the Lower Platte River Basin the relationship is marked. A decrease in precipitation is accompanied by a more rapid decline in crop productivity; however animal units recede at a slower rate. The recovery of crop productivity is much quicker than that of animal units. The Scotts Bluff County projects demonstrate the effect of irrigation. Variations from the mean are not as great, although a shortage of storage water for the North Platte project is reflected in a rapid drop of the crop productivity curve.

Many of the existing systems, lacking ample water supplies and distribution facilities, are considered inadequate. It has been estimated that adequate storage would require 16 additional reservoirs. These, with the existing five impoundments, would provide water for a total of 2,345,100 acres. All dams would provide a total storage capacity of 4,544,000 acre-feet.

Hydroelectric Power

Prospects for developing potential hydroelectric power in the Lower Platte River Basin are good. However, sediment in quantity carried by the streams, being readily deposited because of low velocities resulting from the slight gradients of the rivers, adversely affects the storage capacity of hydroelectric power reservoirs. Also, maximum production of hydroelectric power would curtail potential irrigation developments which possess high priority; though conversely, the irrigation programs depend upon hydroelectric power for operation of district pumps as an integral feature of the planned irrigation system. Under the Basin development plan, with 10 proposed plants under consideration and with 9 of the existing hydroelectric plants remaining in operation, the present output would be exceeded. Table 3 lists the pertinent data and the status of hydroelectric power plants in the Basin.

Recreation - Fish and Wildlife

Existing recreational facilities within the Basin are limited to 3 State parks; 16 areas designated as "State Recreational Grounds"; and 2 privately-owned and operated beach parks in eastern Nebraska. Several areas in the Basin have overnight and weekend accommodations. Although the areas are small and inadequate they provide good fishing. The need for recreation is reflected in the planning of the development program. The State of Nebraska is taking steps to protect public interests against encroachment by private entrepreneurs and has acquired frontage on the Johnson Regulating, Lake McConaughy, Maloney Regulating and Jeffrey Regulating Reservoirs.

A study of the factors of prime importance, such as existing facilities, population, economic status and the recreational habits of the people residing in the Basin, denotes a definite need for the promulgation of a recreational program. This has been supported by

Table 3. Lower Platte River Basin - Hydroelectric Power Plants[1]

Location	Existing Kilowatts	Potential Kilowatts	Status[2]
Platte River and Minor Tributaries			
Columbus	39.900	13,300	E
Riverdale	-	6,840	P
Kearney	2,400	-	A
Plum Creek	-	24,000[3]	P
Bison	-	3,645[3]	P
Johnson[1]	18,000	-	
Johnson[2]	18,000	-	A
Gothenburg	400	-	A
Jeffrey	18,000	-	E
North Platte	26,100	-	E
Elkhorn River			
Nickerson	-	5.570	P
Maple Creek	-	5.330	P
Loup River			
Monroe	7,837	5,225	E
St. Edward	96	96	E
Fullerton	394	394	E
Spalding	235	235	E
Ericson	350	350	E
Cushing	-	5,960	P
Pleasant Hill	-	2,600	P
Davis Creek	-	11,000[3]	P
Boelus	2,000	-	A
Rockville	-	1,830	P
Shaupps	-	3,800	P
Arcadia	-	4,170	P
Sargent[3]	-	-	A
Walworth	-	3,320	P
Ash Creek	-	1,980	P
Georgetown	-	1,520	P
Callaway	135	135	E

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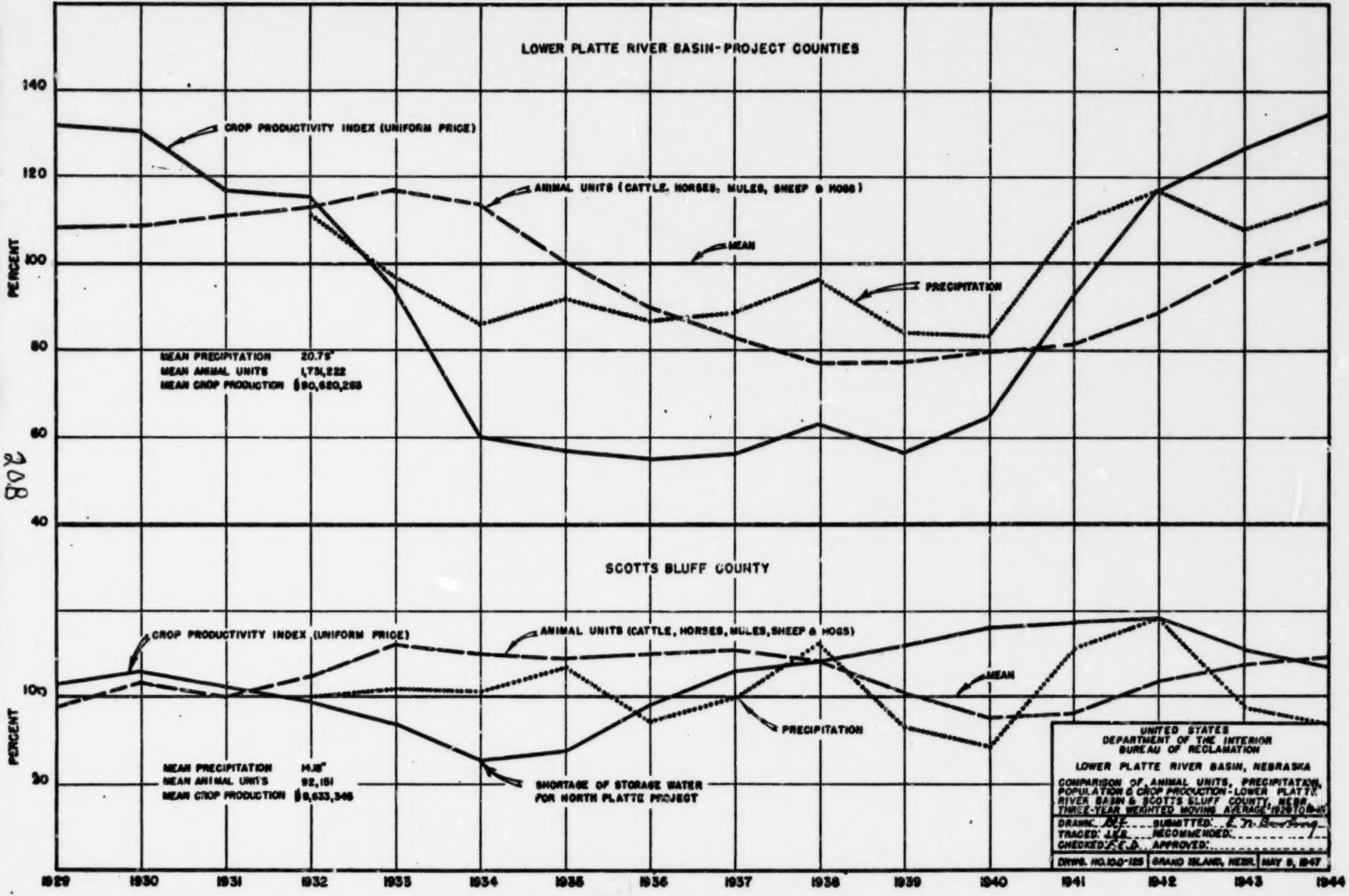
[1] Data from Bureau of Reclamation

[2] Status - E - Existing Plants
A - Existing Plants to be abandoned
P - Proposed Potential Plants

[3] Multiple purpose reservoirs

FIGURE 4.



MEAN PRECIPITATION	20.75"
MEAN ANIMAL UNITS	1,731,222
MEAN CROP PRODUCTION	$90,620,255

MEAN PRECIPITATION	14.18"
MEAN ANIMAL UNITS	92,151
MEAN CROP PRODUCTION	$8,633,346

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

LOWER PLATTE RIVER BASIN, NEBRASKA

COMPARISON OF ANIMAL UNITS, PRECIPITATION, POPULATION & CROP PRODUCTION - LOWER PLATTE RIVER BASIN & SCOTTS BLUFF COUNTY, NEBR. THREE-YEAR WEIGHTED MOVING AVERAGE 1929 TO 1944

DRAWN: RLF SUBMITTED: E. N. Bowling
TRACED: J.E.B. RECOMMENDED:
CHECKED: F.E.D. APPROVED:

DRWG. NO. 100-125 | GRAND ISLAND, NEBR. | MAY 8, 1947 the experience of the State Game Forestation and Parks Commission.

The National Recreational Association has, as a result of extensive research, established a minimum standard of 1 acre of recreational area per 100 persons. In the Basin this would call for 5,200 acres to be set aside as a minimum. Present facilities provide about 2,380 acres, or about 46 percent of the minimum.

Six of the proposed reservoirs: Loretto, Davis Creek, Bison, Rockville, Mullen, and Shell Creek are considered for daily and week-end use only because of their proximity to users who make frequent trips to such areas. The complex operating nature of the reservoir development plan would preclude continued water-surface recreation activity, and downstream as well as upstream activity would have to be substituted in the event of untimely variations of water levels.

Sport fishing appears to constitute the most valued recreation; hunting and surface water sports, such as bathing and boating, are not stressed as they are subject to fluctuations of water level due to reservoir operations.

Benefits accruing to existing recreational facilities are estimated by the National Park Service at approximately $6,000.00 per annum and the total recreation benefits of all potential reservoirs contemplated under the development plan have been placed at $876,000, and include expenditures traveling to and from the reservoirs in addition to the amounts spent at the reservoirs. The Fish and Wildlife Service estimate of $742,000 (table 4) indicates the annual value attached to these forms of recreation in the area directly affected by the development program.

RESERVOIRS AND DIVERSION DAMS

A summary of 21 existing and potential reservoirs is provided in table 5. Data were obtained from the Bureau of Reclamation.

Table 6[1] lists by sub-basins 21 existing and proposed storage dams, and 31 existing and proposed diversion dams. The detailed breakdown shows 5 existing and 7 proposed reservoirs in the Platte River Valley, 1 proposed reservoir in the Elkhorn and 8 proposed reservoirs in the Loup River Valleys. There are 4 existing and 3 proposed diversion dams in the Platte River Valley; 8 proposed for the Elkhorn River Valley; and 8 existing and 8 proposed diversionary structures in the Loup River Valley.

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[1] Includes only major reservoirs and diversion structures.

Table 4. Lower Platte River Basin - Annual fish and wildlife values[1]

Division	Item[2]	Present	Future	Difference
North Platte-Kearney	W	$ 94,400	$ 109,300	$ 14,900
	F	100	10,000	9,900
	Subtotal	94,500	119,300	24,800
Grand Island	W	140,100	145,500	5,400
	F	15,600	32,600	17,000
	Subtotal	155,700	178,100	22,400
Tri-County	W	73,500	73,400	-100
	F	0	10,000	10,000
	Subtotal	73,500	83,400	9,900
Middle Loup	W	32,600	35,400	2,800
	F	13,000	18,200	5,200
	Subtotal	45,600	53,600	8,000
North Loup	W	12,600	11,700	-900
	F	4,000	4,000	0
	Subtotal	16,600	15,700	-900
Cedar Rapids	W	9,700	9,000	-700
	F	8,500	8,500	0
	Subtotal	18,200	17,500	-700
Columbus	W	160,000	142,700	-17,300
	F	6,600	37,400	30,800
	Subtotal	166,600	180,100	13,500
Albion	W	10,700	11,800	1,100
	F	5,600	15,000	9,400
	Subtotal	16,300	26,800	10,500
Elkhorn	W	22,300	20,400	-1,900
	F	21,000	19,000	-2,000
	Subtotal	43,300	39,400	-3,900
Plattehorn	W	18,100	19,600	1,500
	F	11,000	5,500	-5,500
	Subtotal	29,100	25,100	-4,000

Table 4. Lower Platte River Basin - Annual fish and wildlife values[1]--Continued

Division	Item[2]	Present	Future	Difference
Platte River	F	$ 15,000	3,000	-12,000
Total				
All Divisions	W	574,000	578,800	4,800
	F	100,400	163,200	62,800
Grand Total		674,000	742,000	67,600

[1] Data of Fish and Wildlife Service

[2] Item - F - Fish
W - Wildlife

Table 5. Lower Platte River Basin - Summary of Reservoirs - Existing and Potential

	Number	Capacities, 1000 Acre-Feet			
Sub-Basin	of Reservoirs	Conservation	Inactive	Storage	Total
Platte River and Minor Tributaries	12	2,994.30	65.70	805.30	3,865.30
Elkhorn River	1	60	5	57	122
Loup River	9*	1,307	111	418.25	1,836.25
Total	22	4,361.30	181.70	1,280.55	5,823.55

*This includes Lake Babcock with an original capacity of 4,000 acre-feet which has been greatly reduced by silting.

Table 6. Lower Platte River Basin - Reservoirs and diversion projects[1]

Basin, Dams and Diversions[2]	Location by River Miles	
	Main Stem	Tributaries
Platte River		
Shell Creek Dam (Proposed)	P.- 83.5	Sh.Cr.- 10.4
Columbus Diversion Dam (Proposed)	P.- 99.8	
Bellwood Dam (Proposed)	P.-109.0	Cl.Cr.- 24.2
Cairo Dam (Proposed)	P.-117.0	Pr.Cr.- 41.0 Dry Cr.- 8.7
Wood River Diversion Dam (Proposed)	P.-161.4	W.R.- 70.5
Amherst Dam (Proposed)	P.-161.4	W.R.- 88.0
Bison Dam (Proposed)	P.-231.4	Elm Cr.- 2.0 W.Bu.Cr.- 32.6
Bertrand Dam (Proposed)	P.-240.0	
Plum Creek Dam (Proposed)	P.-245.6	P.C.- 24.2
Lexington Diversion Dam (Proposed)	P.-250.0	
Johnson Dam (Existing)[3]	P.-253.0	
Brady Diversion Dam (Existing)	P.-289.5	
Jeffrey Dam (Existing)[3]	P.-292.5	
Maxwell Diversion Dam (Existing)	P.-309.0	
Keystone Diversion Dam (Existing)	P.-309.8	N.P.- 54.5
Kingsley Dam (Existing)	P.-309.8	N.P.- 54.7
Maloney Dam (Existing)	P.-309.8	S.P.- 1.2
Sutherland Dam (Existing)[3]	P.-309.8	S.P.- 23.4
Korty Diversion Dam (Existing)	P.-309.8	S.P.- 42.3
Elkhorn River		
Hooper Diversion Dam (Proposed)	E.- 42.2	
Union Creek Diversion Dam (Proposed)	E.-127.2	
Norfolk Diversion Dam (Proposed)	E.-144.0	
Battle Creek Diversion Dam (Proposed)	E.-158.0	
Cedar Creek Diversion Dam (Proposed)	E.-184.7	
Neligh Diversion Dam (Proposed)	E.-197.8	
Rosedale Dam (Proposed)	E.-199.5	Cl.Cr.- 4.0
South Fork Diversion Dam (Proposed)	E.-210.1	S.F.E.- 4.5
Ewing Diversion Dam (Proposed)	E.-214.5	
Loup River		
Loretto Dam (Proposed)	L.- 25.1	Be.C.- 51.0
Genoa Diversion Dam (Existing)	L.- 31.3	
Belgrade Diversion Dam (Proposed)	L.- 40.0	Ce.R.- 21.0
Ericson Dam (Proposed)	L.- 40.0	Ce.R.- 62.3
Cushing Dam (Proposed)	L.- 66.5	Sp.C.- 2.0
St. Paul Diversion Dam (Proposed)	L.- 66.5	

See footnotes on last page

Table 6. Lower Platte River Basin - Reservoirs and diversion projects[1] Continued

Basin, Dams and Diversions[2]	Location by River Miles	
	Main Stem	Tributaries
Loup River - Continued		
Cotesfield Diversion Dam (Proposed)	L.- 67.5	N.L.- 16.8
Davis Creek (Proposed)	L.- 67.5	N.L.- 21.0 Da.C.- 0.3
Hardenbrook Diversion Dam (Existing Rehabilitation)	L.- 67.5	N.L.- 42.5
Burwell Diversion Dam (Existing, improvements required)	L.- 67.5	N.L.- 65.0
Taylor Diversion Dam (Existing)	L.- 67.5	N.L.- 85.4
Almeria Diversion Dam (Existing)	L.- 67.5	N.L.- 95.7
Newton Diversion Dam (Existing)	L.- 67.5	N.L.-105.0
North Loup Storage (Proposed)	L.- 67.5	N.L.-153.0
Turkey Creek Diversion Dam (Proposed)	L.- 67.5	M.L.- 8.6 T.C.- 13.0
Ashton Dam (Proposed)	L.- 67.5	M.L.- 14.8 O.C.- 29.5
Ravenna Diversion Dam (Proposed)	L.- 67.5	M.L.- 25.2 S.L.- 28.0
Cumro Diversion Dam (Proposed)	L.- 67.5	M.L.- 25.2 S.L.- 77.9
Rockville Dam (Proposed)	L.- 67.5	M.L.- 37.1
Arcadia Diversion Dam (Existing)	L.- 67.5	M.L.- 72.0
Sargent Diversion Dam (Existing Rehabilitation)	L.- 67.5	M.L.- 86.7
Milburn Diversion Dam (Proposed)	L.- 67.5	M.L.-111.8
Dismal River Diversion Dam (Proposed)	L.- 67.5	M.L.-129.7 D.R.- 14.7
Mullen Dam (Proposed)	L.- 67.5	M.L.-204.0

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[1] Exclusive of Lake Babcock, Lake Helen, Lake Ericson, Pikel Lake and canyon reservoirs along the Jeffrey and Johnson Supply Canals for which adequate data are not available. Major dams only are listed.

[2] Date from Bureau of Reclamation.

[3] These reservoirs are parts of a small system lying south of the Main Stem Platte River. River miles present their approximate location.

REVIEW OF NEBRASKA WATER POLLUTION LAWS

In accordance with the provisions of the "Memorandum of Understanding", appendix A, there follows a critical review of the water pollution laws of Nebraska together with information regarding pending legislation. For detailed information on the subject of State water pollution control legislation and suggested criteria for component parts, see appendix B.

Administrative Authority

Nebraska does not have a comprehensive water pollution law and there is no statutory requirement for the development of a broad water pollution control program or the administrative enforcement thereof. Comprehensive water pollution control legislation should be enacted as soon as possible. The only statutory authority for water pollution control in Nebraska is given in Section 81-602, Revised Statutes of Nebraska which states, "The Department of Health shall have general supervision and control over matters relating to public health and sanitation . . . . ."

The State Health Department is authorized by this statute to adopt reasonable rules and regulations as will best serve to promote sanitation throughout the State.

The Attorney General has ruled that the State Health Department is the Water Pollution Control Agency for the State.

Definitions

Definitions of the terms "sewage", "industrial wastes", "other wastes", etc., should be included in comprehensive water pollution legislation adopted for Nebraska (appendix B).

Section 37-516, Revised Statutes of 1943, defines "refuse" as all substances harmful to aquatic life and forbids its discharge into the waters of the State. However, this statute exempts corporations, villages, and cities of the second class discharging sewage or refuse prior to August 21, 1931 and is not of great value to a general pollution control program.

Powers and Duties

Comprehensive Programs: Cooperation - The powers and duties of the State Health Department appear to be quite limited as far as water pollution is concerned. The functions of the Sanitation Division of the Health Department are principally advisory and educational.

The Nebraska State Health Department, while not specifically authorized to do so by statute, does cooperate with various State and Federal agencies in connection with water pollution control problems. Such cooperation should be authorized by statute.

Investigations - The State Health Department conducts water pollution investigations under the very general authority granted to it by the statutes. More specific authority would be desirable (appendix B).

Stream Standards and Classification - There is no specific authority for classification of waters according to use or the adoption of stream standards. Section 81-602 might possibly be construed to grant this authority, but specific legislation is needed.

Rules and Regulations - General health department authority for the adoption of rules and regulations is contained in Section 81-602 but specific authority in the field of water pollution control is needed (appendix B).

Permits - No permit system is now in operation. Such a system is considered administratively desirable and should be included in future water pollution control legislation.

Orders for Pollution Abatement - There is no specific authority provided by statute; however, the State Health Department presumably could act if there was a serious public health hazard. Specific authority is needed to cover the abatement of all forms of pollution and should not be limited to public health problems alone. It should include, as well, pollution detrimental to all other water uses (appendix B).

Plans and Specifications - Submission is required by the State Health Department rules and regulations for systems serving more than 25 persons. No mention is made of plans for industrial waste treatment plants, however.

Federal Water Pollution Control Act - There is no specific statutory authority for cooperation with the Federal Government in connection with Public Law 845.

Division of Authority - There is some division of authority and responsibility between the State Fish and Game Agency and the State Health Department. The State Fish and Game Agency may take action through county attorneys to secure abatement of pollution harmful to aquatic life. In the enactment of comprehensive water pollution control legislation, a single state agency should be designated and its powers should be broad enough to include this and all other types of water pollution problems.

Enforcement

Penalties are provided for failure to comply with the Health Department's rules and regulations. Fines vary from $15 to $100 for each offense. As far as water pollution is concerned enforcement provisions appear to be deficient. This phase of a comprehensive pollution law is important and should be included in future legislation.

Sanitary Districts

Section 31.701, et seq, Revised Statutes, Supplement, 1947 indicate that sanitary districts may be formed and that such districts may provide for the construction and maintenance of necessary sewage works (certain areas may not be included in such districts). General obligation bonds up to 10 percent of the assessed valuation of taxable property may be issued. Revenue bonds may also be used to finance such projects and in such cases the 10 percent limit does not apply.

Statutes Governing Financing of Pollution Abatement Works

All villages and cities may issue "mortgage bonds" (section 18-502). These bonds do not impose any general liability upon the municipality and are secured by the property; e.g., the sewage works, and revenues derived therefrom. This is the equivalent of sewer service charge financing and is undoubtedly of considerable value to the municipalities in financing sewage treatment works.

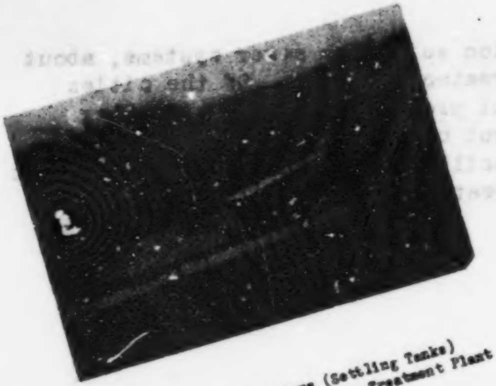
All cities and villages are authorized by Section 18-501, et seq, to own, construct, equip and operate sewage works within or outside the city or village. They may condemn the lands needed, levy taxes, issue bonds, or as previously noted, mortgage bonds in accordance with statutory provisions. Cities and villages may also adopt rules and regulations governing the use of sewers and treatment plants and charges for the use of same. If the charge is not paid the city or village may recover by action of assumpsit or the charge may be certified to the tax assessor and assessed against the property served.

Municipal finance laws have never retarded the progress of water pollution abatement in Nebraska.

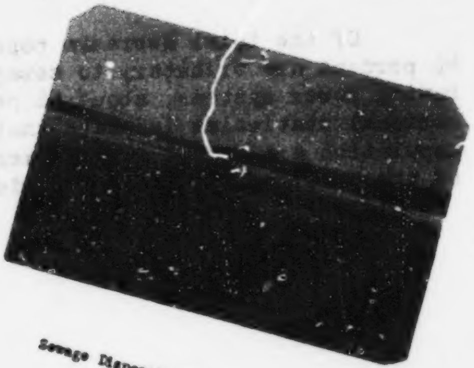
Water Pollution Control Program

Nebraska has a fairly good record in water pollution control and the State Health Department enjoys the confidence of State and city officials, and the public at large. Undoubtedly the State's program has been seriously handicapped by inadequate statutory backing. This is a definite need. Another serious handicap has been lack of a sufficient number of competent engineers on the State Health Department's staff. Present key personnel are experienced and competent but cannot handle the work throughout the State unaided. Funds should be provided for increasing the engineering staff assigned to pollution control work.

Of the total Nebraska population served by sewer systems, about 46 percent are tributary to sewage treatment plants. Of the cities having sewer systems, about 56 percent provide treatment. Similar national statistics indicate that about 63 percent of the sewered population are served by treatment facilities and that about 61 percent of the sewered communities provide treatment.



Primary Clarifiers (Settling Tanks)
Grand Island, Nebr., Sewage Treatment Plant



Sewage Disposal Lakes - Alliance, Nebr.

Platte River near Grand Island, Nebr.

SURVEY METHODS

The investigation of water pollution and water utilization in the Lower Platte River Basin included:

(a) Field investigations to secure most recent and accurate information regarding (1) water supplies and water utilization and (2) sources of pollution including sewage treatment, sewage discharge and industrial wastes.

(b) Sampling program and laboratory determinations to secure various physical, chemical and bacteriological information on stream conditions as a means of correlating actual stream characteristics with sources of pollution.

(c) Stream discharge data at time of sampling so that laboratory results could be evaluated quantitatively with sources of pollution.

(d) Assembly and review of existing information.

FIELD INVESTIGATIONS

Field surveys of water supplies and sources of pollution were conducted by Sanitary Engineers from the Nebraska State Health Department and Public Health Service. In special cases laboratory studies supplemented these investigations, particularly when unknown factors required evaluation. In evaluating industrial and domestic pollution, data were submitted by the Nebraska State Health Department to the Missouri Drainage Basin Office for review, and for calculation or checking of population equivalents of waste discharge. In all instances, completed tabulations were given final checking and approval by the State Health Department.

Water Supply

The water supply data collected for each municipality included the source of supply, treatment if any, population served and average consumption. Latest population estimates were employed in most cases to arrive at the population served by water systems. Industrial and agricultural use of water was also investigated.

Sources of Pollution

Domestic Sewage - For each municipality, the data gathered included the sewered population, type and degree of treatment if any, and receiving body of water. The percentage B.O.D. removal by treatment plants, where records or supplemental information were not

available, was generally taken as 35 percent for primary treatment and 75 percent for secondary treatment. However, the judgment and experience of the investigating engineer were depended upon to evaluate treatment processes where inspection indicated exceptionally good results, an overloaded plant, inefficient or faulty operation. In a few instances grab samples,or composites from a 24-hour period,were analyzed to provide actual efficiency records.

Industrial Wastes - All industrial establishments discharging a significant pollutional waste were investigated to secure information in sufficient detail to permit a quantitative evaluation of the pollutional load based on population equivalents. Survey forms completed on industries included the following information: type of industry, location, operation (with seasonal variation), water supply, quantity of raw materials, quantity of finished products, treatment of wastes if any, and receiving body of water. The industrial waste was expressed as population equivalents based upon 0.167 pounds per day of 5-day 20° C., Biochemical Oxygen Demand (B.O.D.) per person.

Population equivalent unit values were obtained from the Industrial Waste Guides, Ohio River Pollution Survey and supplemented by figures from other sources. The paucity of reliable information on wastes from potato chip plants made it desirable to establish the relationship between population equivalent and production during this survey which was done by conducting a detailed study over the operating cycle at one of the plants. This study is discussed in detail in appendix C.

The principal industries encountered in this area were slaughtering, meat packing, rendering plants, dairies, poultry dressing, and beet sugar refineries.

Sewered Population Equivalent - To arrive at the pollution produced by a given community, the sewered population equivalent of industrial wastes was added to that of the sewered population and shown as the total sewered population equivalent. The waste discharged was computed as the sewered population equivalent minus any treatment either by the municipality, industries, or combined.

SAMPLING POINTS

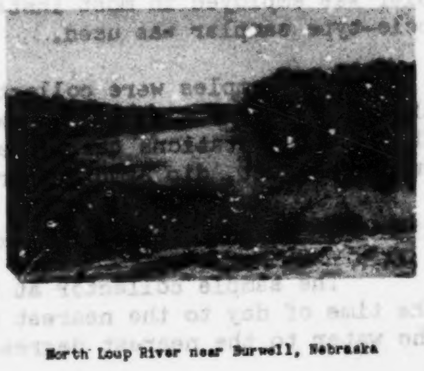
Establishment of Sampling Points

Stream sampling stations were established at water supply intakes, above and below sources of known or suspected pollution, in the vicinity of existing or proposed dams and diversions, at points where other water uses might develop, and at suitable points at the mouths of tributaries. In areas where significant pollution was expected intermediate points were added. In most instances single samples were collected but on the larger streams cross sectional sampling at quarter

Sample Collection with Deep Water Sampler

Stream Staging (U.S.G.S. Wire-weight Gage)

South Loup River near Ravenna, Nebraska



North Loup River near Burwell, Nebraska

or third points was the practice, depending upon channel characteristics.

Conveniently located bridges were utilized wherever possible for sampling locations. In the absence of bridges, suitable walk-in points were selected.

Sampling stations were designated by description and river miles above the mouth of the stream (appendix F).

Number of Sampling Stations

A total of 125 sampling points were established. One thousand one hundred and twenty two samples were analyzed for an average of approximately 9 samples from each station (figure 5).

Number of Sampling Stations by Sub-Basins

Basin	Main Stem	Tributaries	Total
Lower Platte River	21	23	44
Loup River	5	8	13
North Loup River	7	2	9
Middle Loup River	7	1	8
South Loup River	2	3	5
Elkhorn River	16	11	27
Niobrara River[1]	5	12	17
Ponca Creek	2	0	2
Totals	65	60	125

[1] The Niobrara Basin will be the subject of another report.

Sampling Procedure

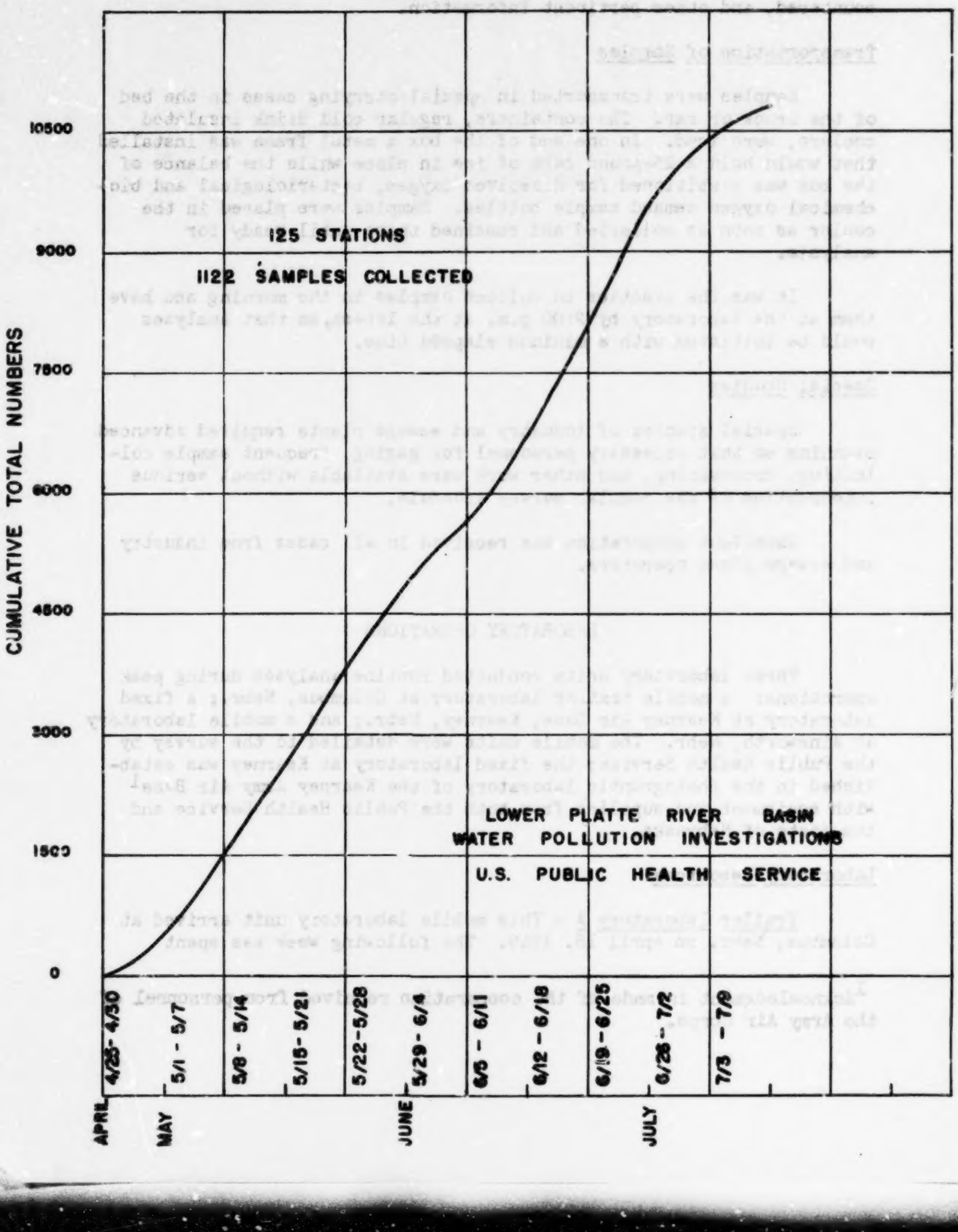
Sampling was conducted to secure a representative portion of the stream in question. The sample was drawn from the main channel or channels, and if at all possible, from mid-depth. A copper depth sampler was employed in most instances. With shallow streams, a special pole-type sampler was used.

Dip samples were collected when the water was too shallow to use the pole sampler. The wide, extremely shallow, stream beds at some of the sampling stations carried a flow of several c.f.s. and rather than omit the point, dip sampling procedure was resorted to in a few cases.

Data Obtained by Sample Collector

The sample collector at the time of sample collection recorded the time of day to the nearest minute, determined the temperature of the water to the nearest degree centigrade, and staged the stream as

FIGURE 5. CUMULATIVE NUMBERS OF TESTS MADE TC END OF WEEK



described in the section on stream discharge data. The sample collector also recorded as "remarks" any unusual stream conditions, noted the presence of possible sources of pollution, road conditions encountered, and other pertinent information.

Transportation of Samples

Samples were transported in special carrying cases in the bed of the truck or car. The containers, regular cold drink insulated coolers, were iced. In one end of the box a metal frame was installed that would hold a 25-pound cake of ice in place while the balance of the box was partitioned for dissolved oxygen, bacteriological and biochemical oxygen demand sample bottles. Samples were placed in the cooler as soon as collected and remained there until ready for analysis.

It was the practice to collect samples in the morning and have them at the laboratory by 2:00 p.m. at the latest, so that analyses could be initiated with a minimum elapsed time.

Special Studies

Special studies of industry and sewage plants required advanced planning so that necessary personnel for gaging, frequent sample collecting, compositing, and other work were available without serious interruption of the regular survey schedule.

Excellent cooperation was received in all cases from industry and sewage plant operators.

LABORATORY OPERATIONS

Three laboratory units conducted routine analyses during peak operations: a mobile trailer laboratory at Columbus, Nebr.; a fixed laboratory at Kearney Air Base, Kearney, Nebr.; and a mobile laboratory at Ainsworth, Nebr. The mobile units were detailed to the survey by the Public Health Service; the fixed laboratory at Kearney was established in the photographic laboratory of the Kearney Army Air Base[1] with equipment and supplies from both the Public Health Service and the State of Nebraska.

Laboratory Resources

Trailer Laboratory A - This mobile laboratory unit arrived at Columbus, Nebr. on April 18, 1949. The following week was spent

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[1] Acknowledgment is made of the cooperation received from personnel of the Army Air Corps.

Conducting Analyses at Fixed Laboratory - Kearney, Nebraska

Mobile Laboratory Units

training new personnel in their duties. Laboratory analyses of stream samples started on April 25, 1949 and continued to the first of July. The sampling area covered by this unit was the Platte River and its tributaries from the Platte River Bridge near Ashland, Nebr. to the Platte River Bridge just west of Central City, Nebr. Normal operating staff included a chemist-bacteriologist, a laboratory assistant, and two sample collectors.

Kearney Laboratory - The equipping of a fixed laboratory at the Kearney Air Base was started April 28, 1949. Sampling and analytical work was initiated May 2, 1949, and the laboratory was in continuous operation until July 13, 1949. The sampling area for this laboratory was the Platte River and its tributaries starting at Grand Island, Nebr. and continuing west to Lewellen, Nebr. on the North Platte River; and Paxton, Nebr. on the South Platte River.

Personnel included a chief chemist, two laboratory assistants, and two sample collectors for most of the period.

The Kearney laboratory was used as a base for supplies and equipment for mobile units and sample collecting cars. The trailer laboratories were furnished with necessary reagents, chemicals and standard solutions as needed. All standard solutions and reagents were prepared and tested before shipment to the mobile units.

Trailer Laboratory B - The second mobile laboratory arrived on location at Ainsworth, Nebr. June 8, 1949. Laboratory analysis started on June 10 and continued until June 29, 1949. The objective of this laboratory unit was to sample the Niobrara River and its tributaries, and Ponca Creek.

The normal complement of this mobile unit was one chemist-bacteriologist, a laboratory assistant, and a sample collector.

Data collected in the Niobrara Basin will be presented in a later report.

Total Number of Determinations

A total of 1,122 samples were collected from regular established stream points on which 10,825 determinations were made (figure 5). Additional samples and analyses were made on sewage treatment plants and industrial wastes.

Laboratory Tests

Routine laboratory tests included temperature, turbidity, dissolved oxygen, biochemical oxygen demand, pH, alkalinity, chloride, ammonia, nitrite nitrogen, nitrate nitrogen, and coliform group organisms. Other tests made were phosphate, settleable and suspended solids.

Temperature - The temperature of a water controls the oxygen solubility and thus the saturation level of dissolved oxygen in the stream. The rate of natural purification and bacterial growth is increased or diminished with higher or lower temperatures, respectively.

Turbidity - Turbidity of water is due to suspended matter. This suspended material may be particles that will settle out with quiescence, or may be colloidal in nature. Turbidity measurement gives an approximation of the amount of silt and other suspended material carried by the stream. To a limited extent a correlation exists between turbidity, B.O.D. values and high or low stream stages.

pH - pH is defined as the negative logarithm of the hydrogen ion concentration. The pH value indicates the relative acidity or alkalinity of a water, with the neutral point at pH 7.0. Values lower than 7.0 indicate the presence of acid salts; from pH 7.0 to 14.0 the presence of alkalies or alkaline earth salts.

Alkalinity - The alkalinity of a water usually indicates the presence of carbonates, bicarbonates, hydroxides, and occasionally borates, silicates and phosphates. In comparison with pH, alkalinity may be considered as a quantity factor while pH would be an intensity factor.

Chloride - The chloride content of a stream in many cases can be used as an indication of the entrance of domestic sewage or trade wastes.

Dissolved Oxygen - Normally the amount of oxygen dissolved in stream water is limited by the saturation value (9.17 ppm at 20° C.), a function of water temperature. However, in some cases, as a result of the photosynthetic action of some water plants, including algae, this value may be exceeded, causing "supersaturation". To support fish and aquatic life and for the natural aerobic purification of stream waters, dissolved oxygen must be present, the minimum quantity permissible being dependent on the quality of water desired and stream flows. Satisfactory methods of waste disposal to the streams depend on the relationship between character, quantity and strength of the wastes, and the character and discharge volume of the receiving stream. Varying dissolved oxygen values below the saturation level are an indication of the presence of organic pollution, which in process of stabilization, is utilizing oxygen from the stream water. A measure of the degree of pollution of a particular area is given by the deficiency in the dissolved oxygen content below saturation.

Biochemical Oxygen Demand - The standard test for biochemical oxygen demand (B.O.D.) requires five-day incubation at 20° C. of sealed samples of the water under examination and a determination of the loss of dissolved oxygen during that time. Where the loss may be greater than the initial dissolved oxygen present, the sample is diluted with standard B.O.D. free dilution water and the measured loss multiplied by the appropriate dilution factor.

The B.O.D. thus determined becomes a measure of the amount of oxygen necessary under stated conditions of time and temperature to satisfy the biochemical oxidation requirements of the pollution present at the time the sample was collected. Since the amount of dissolved oxygen present decreases with rising temperatures and at the same time the rate of biochemical oxidation increases as the temperature rises, critical stream conditions usually result during the warm months, particularly since these high temperatures are often combined with low stream flows.

Ammonia, Nitrite, and Nitrate Nitrogen - Determination of these constituents is useful in the evaluation of the degree and probable time of pollution. They give definite evidence of stream conditions and extent of recovery or natural purification under normal stream flow. These tests may also reflect the use of fertilizers when return irrigation waters are present in the stream.

Coliform Group Organisms - This determination gives the most accurate estimation of the degree of pollution by sewage, since it shows the approximate density of sewage type organisms that are normally found only in very small numbers in natural or unpolluted streams. Coliform bacteria are normally present in the intestines of warm-blooded animals and are discharged in vast number in human feces, which constitute the main source of these bacteria in sewage.

Procedures

Chemical and bacteriological examinations and analyses were made in accordance with "Standard Methods for the Examination of Water and Sewage", Ninth Edition, 1946, of the American Public Health Association. Where there was any choice in equipment, supplies or procedure, or any deviation made from standard procedure, such variation was designed as an added safety factor.

SPECIAL STUDIES

Potato Chip Plants

The plant selected for study was visited by a representative of the State Health Department and by the chemist in charge of the field unit. Pertinent information was collected from the plant officials and other plant personnel to give a comprehensive and com- production schedule of all operations. Plant records of daily production were secured.

The procedure followed was to determine waste flow and collect representative samples which were then composited according to the flow. Samples from the individual plant being checked were stored in an iced container throughout the sampling period and then transported iced, to the laboratory for analysis.

Detailed operating data covering the period of sampling were obtained from the plant. This was broken down into hourly rate, operating peak, noon hour or rest periods and total production for the entire period. Additional detailed information was secured from the proper plant source.

Laboratory analyses included the following: Biochemical Oxygen Demand, suspended solids (total, fixed, and volatile) and settleable solids (1 hour). Results of this study are presented in appendix C.

Sewage Plant Studies

Catch and composite samples were taken at a number of sewage plants and laboratory analyses completed. In most cases sewage samples were collected by representatives of the State Health Department and delivered to the most convenient fixed or trailer laboratory. Where extended composite samples were taken, laboratory and field personnel from the survey crew cooperated in the collection. The laboratory analyses included the following determinations: pH, B.O.D., settleable solids, suspended solids, and alkalinity. Results of sewage plant studies are used by State personnel.

Dissolved Oxygen

A study was made for streams of the Lower Platte River Basin to determine whether dissolved oxygen samples fixed in the field would give results significantly different from dissolved oxygen samples run in the laboratory without prior field treatment. The study included 146 pairs of results. Samples fixed in the field were carried through the iodine stage and then brought to the laboratory for the remainder of the test. Samples brought directly to the laboratory without field fixation were iced, and transportation times were as long as 8 hours in a few cases, but in the majority of cases were less than 6 hours.

Samples fixed in the field gave results approximately 0.05 parts per million higher on the average than those run in the laboratory, which difference is within the probable error of the dissolved oxygen test. Statistical analysis of the data indicated that the differences between results were distributed approximately according to the law of chance. It was concluded that for the streams of the Lower Platte River Basin there was apparently no significant difference between dissolved oxygen fixed in the field and those run in the laboratory without field fixation.

STREAM DISCHARGE DATA

In order to correlate laboratory results with the pollution reaching the rivers it is necessary to secure actual stream discharge at the time of sampling. Arrangements were made with the District Office, Geological Survey at Lincoln, and the Grand Island Area Office, Bureau of Reclamation, to develop cooperative action to secure this information. The complete list of sampling stations and weekly itinerary of sample collectors were forwarded to the Geological Survey who then correlated the activities of their men with the sampling routes. In many instances streams having no gaging stations were rated for this survey by the U. S. Geological Survey. Many of the sampling stations were jointly checked in the field by personnel of the U. S. Geological Survey and of the pollution survey to assure that both groups were gaging the same station. Sawed V-notches or red arrows painted on bridge handrails were used as reference points.

Sample collectors were instructed by representatives of the U. S. Geological Survey on methods of reading gages and staging streams. Then, as each sample was collected, U. S. Geological Survey gages were read, wire weight reading made, or stream heights determined with a weighted tape provided for this purpose by measuring the height from the water surface to a marked point on a bridge. Readings were made to the nearest one-hundredth of a foot and recorded on the data sheets.

Records of sampling with the gage reading or stage height, time and date of sampling, sampling point location, and river mile index were submitted to the U. S. Geological Survey for flow determination. At the request of the U. S. Geological Survey temperature readings were also submitted for their information and use.

PRESENTATION OF DATA

Public Water Supplies

Water supply data are summarized in table 7 and depicted in figure 6. Delineations of these data are included under the respective sub-basin sections.

One hundred and forty-six communities have public water supplies serving a total population of 257,560. Ord, Nebr., is the only community obtaining its water from a stream, the North Loup River, and supplies 2,600 consumers.

Treatment problems are limited generally to the reduction of iron, manganese, and hardness. Chlorination is employed in some instances to insure a biologically safe water.

Pollution Contributed to Water Resources

Summation data are compiled in table 7 and presented in figure 7. Detailed analyses of survey data are discussed in sub-basin sections including sewered populations, industrial wastes, total wastes produced, and population equivalents discharged after treatment. Seventy-one communities, including 33 industries, produce wastes equivalent to a population of 410,700; however, through treatment, this is reduced 27 percent to a waste discharge of 300,700 population equivalents.

The sewered population equivalent of a municipality includes the population equivalent of the organic wastes of industry in or near the municipality. Besides high organic or B.O.D. content, industrial wastes may contain: high suspended solids; chemicals toxic to aquatic life; excess acid, alkalinity or hardness; taste and odor producing substances; or undesirable coloring matter. Table 8 shows the number of industrial establishments surveyed in each sub-basin. One hundred and thirty-seven plants were visited; the principal industries and those producing the most wastes were dairy establishments, and those associated with livestock and meat packing.

Industries in this Basin generally discharge their wastes to municipal sewerage systems and are rightfully included as part of the municipality from a waste disposal standpoint. Industry is usually small to moderate in size and discharges, in most instances, an organic waste amenable to sewage treatment. In this study industry cooperated fully and assisted greatly in the evaluation of their pollutional discharges. The contact with management of industry indicated an awareness of pollution problems and readiness to consider preventative and curative procedures.

Table 7. Lower Platte River Basin - Summary - Water supplies and sources of pollution

	Municipal Water Supplies				Sources of Pollution						
	Surface		Ground		Domestic		Industrial				
River Sub-Basin	No.	Population Served	No.	Population Served	No. of Municipalities	Sewered Population	No. of Industries	Population Equivalent (B.O.D.)	Total Population Equivalent	Discharged Population Equivalent	% Removal by Treatment
Platte River and Minor Tributaries	0	0	59	185,510	22	166,590	10	103,965	270,550	168,430	38
Elkhorn	0	0	47	44,930	33	58,430	14	57,730	116,160	112,230	3
Loup	1	2,600	40	27,120	16	17,930	9	6,055	23,990	20,070	16
Total - Lower Platte River Basin	1	2,600	146	257,560	71	242,950	33	167,750	410,700	300,730	27

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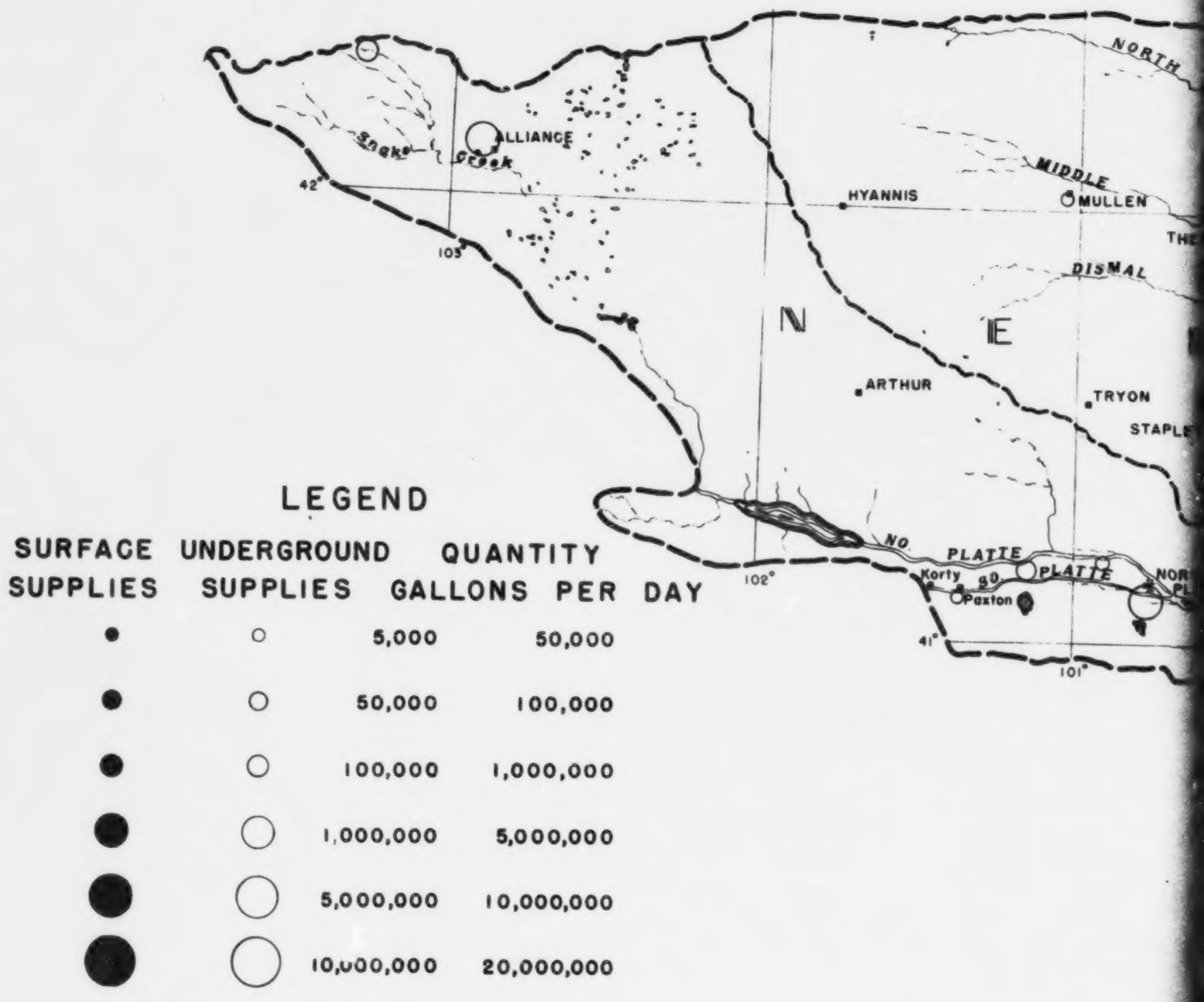
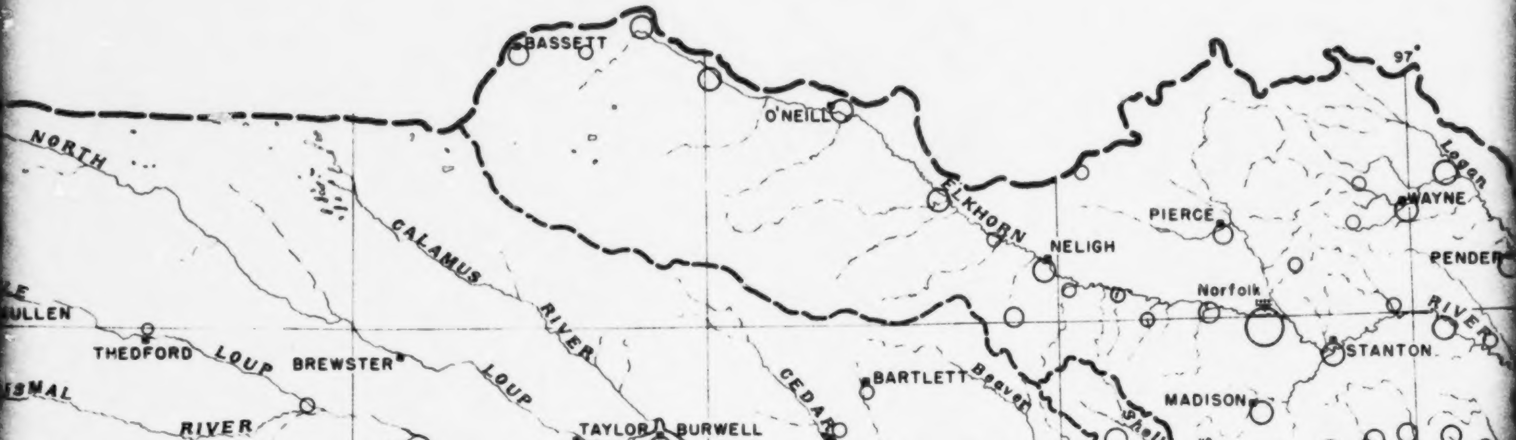

NORTH
ALLIANCE
Snake Creek
42°
103°
HYANNIS
MIDDLE
MULLEN
THE
DISMAL
N
E
ARTHUR
TRYON
STAPLE
NO. PLATTE
PLATTE
SO. PLATTE
Korty
Paxton
NOR
PL
102°
41°
101°
LEGEND
SURFACE SUPPLIES
UNDERGROUND SUPPLIES
QUANTITY GALLONS PER DAY
● ○ 5,000 50,000
● ○ 50,000 100,000
● ○ 100,000 1,000,000
● ○ 1,000,000 5,000,000
● ○ 5,000,000 10,000,000
● ○ 10,000,000 20,000,000

B



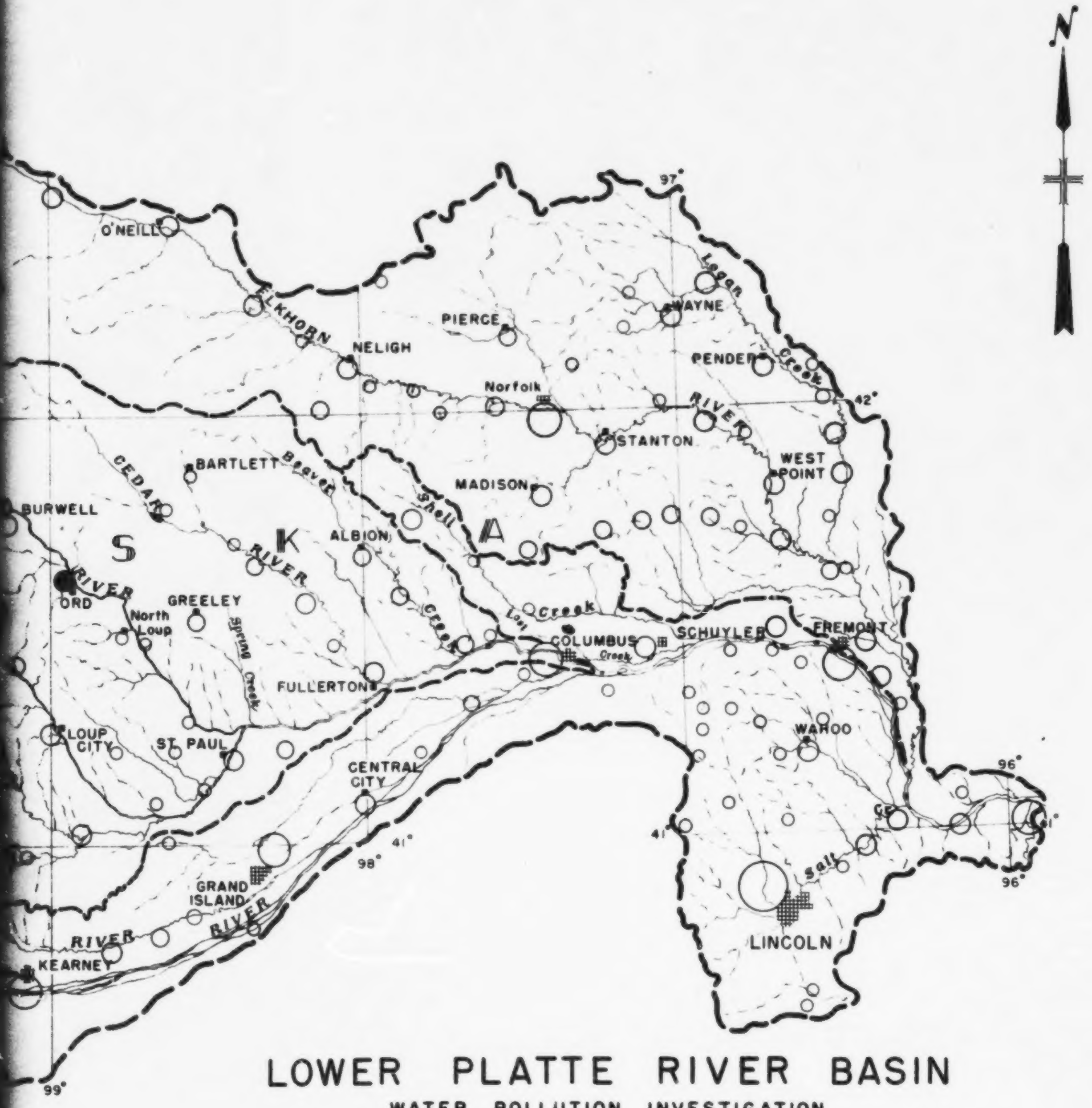
LOWER PLATTE RIVE
WATER POLLUTION INVESTIG
1949
MUNICIPAL WATER SU

U.S PUBLIC HEALTH SERVICE

10 0 10 20 30 4
MILES

44-B

C FIGURE 6.



LOWER PLATTE RIVER BASIN

WATER POLLUTION INVESTIGATION

1949

MUNICIPAL WATER SUPPLIES

U. S PUBLIC HEALTH SERVICE

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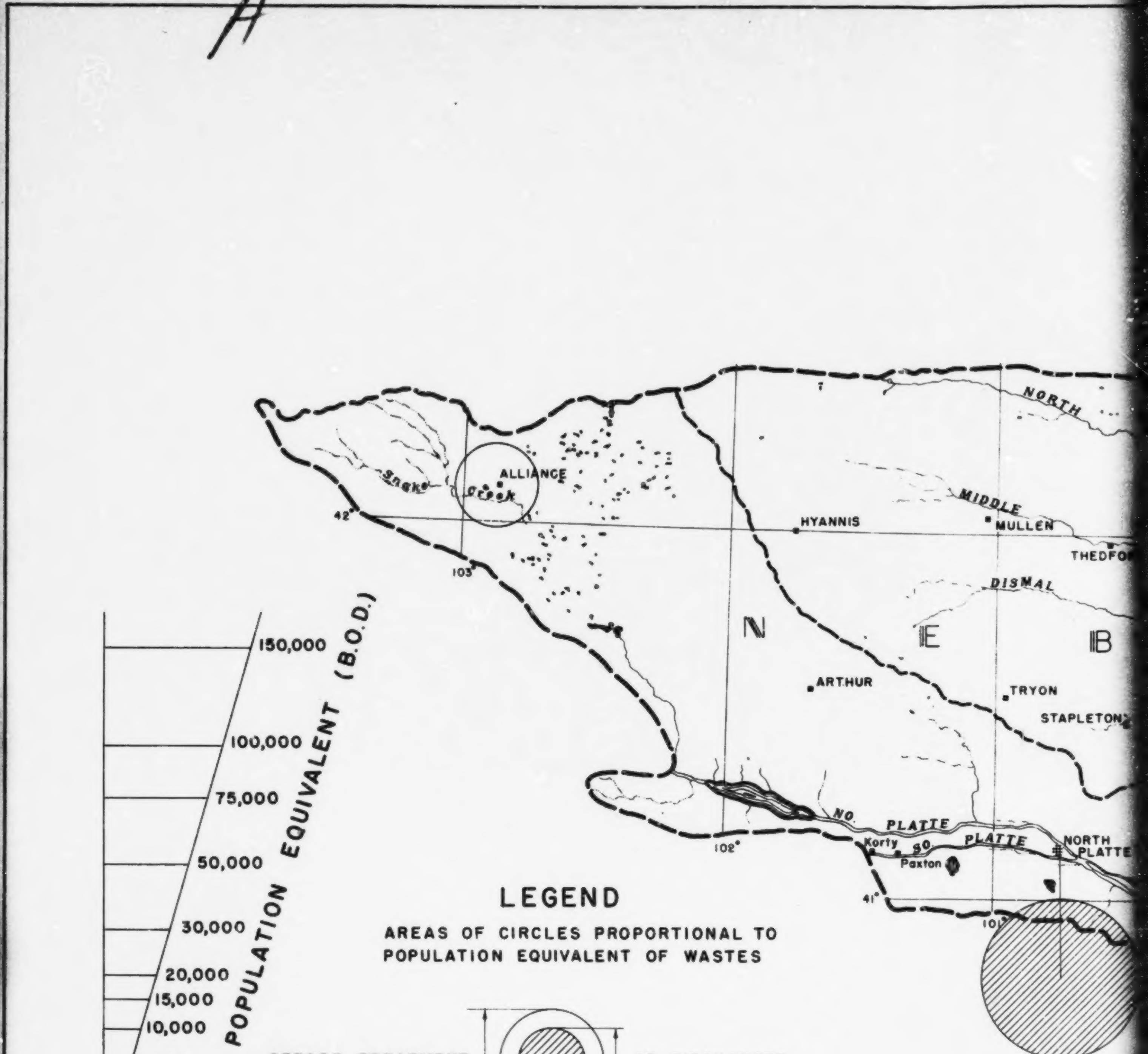
MILES

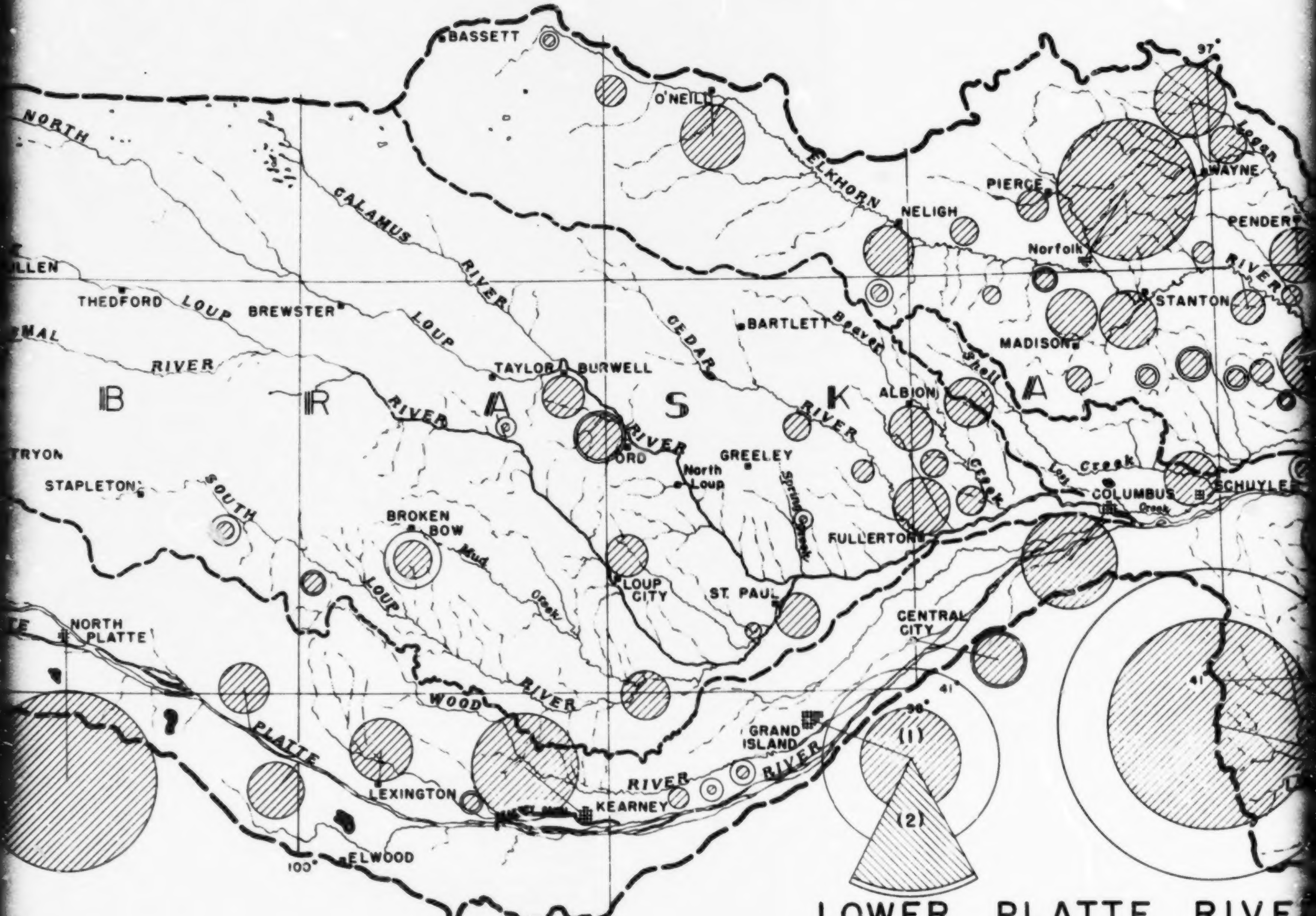
A



LEGEND

AREAS OF CIRCLES PROPORTIONAL TO POPULATION EQUIVALENT OF WASTES

B



LOWER PLATTE RIVE

WATER POLLUTION INVESTIGA

APRIL, MAY, JUNE, JULY / 1949

SOURCES OF POLLU

(1) POPULATION EQUIVALENT DURING SURVEY

(2) POPULATION EQUIVALENT WITH SUGAR BEET REFINERY OPERATION

U.S PUBLIC HEALTH SERVICE

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MILES

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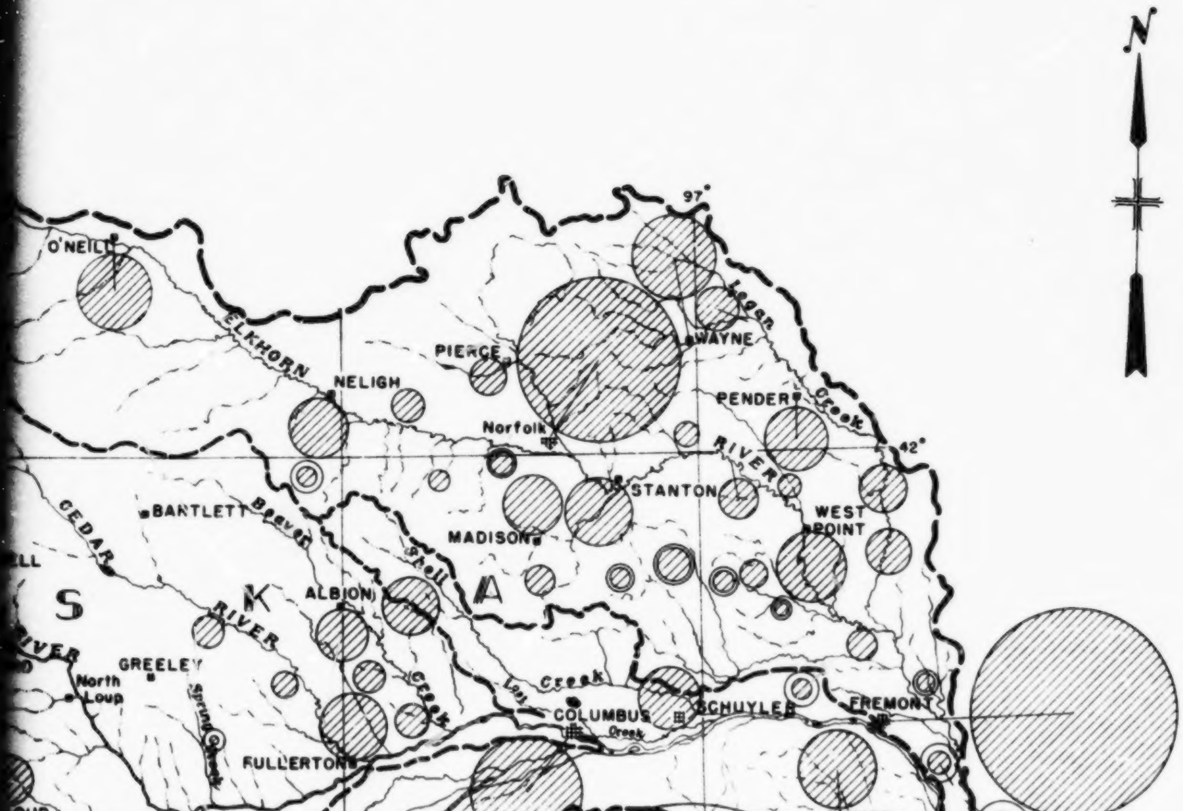
FIGURE 7.

C



LOWER PLATTE RIVER BASIN
WATER POLLUTION INVESTIGATION
APRIL, MAY, JUNE, JULY / 1949
SOURCES OF POLLUTION

EY

BEET

U.S PUBLIC HEALTH SERVICE

10 0 10 20 30 40
MILES

Table 8. Lower Platte River Basin - Industrial establishments surveyed

	Basin			
Industry	Platte River	Elkhorn River	Loup River	Total
Dairy	26	18	12	56
Packing House	8	2		10
Rendering	5	6	1	12
Stockyard	1			1
Slaughter House	8	4	7	19
Hog Cholera Serum	1			1
Chemical Plant		1		1
Brewery	1			1
Poultry Dressing	8	9	2	19
Receiving Stations	6	2		8
Potato Chip	2			2
Feed Mills	2			2
Hatchery	2			2
Machine Shops	2			2
Sugar Refinery	1			1
Total	73	42	22	137

DISCUSSION

Water Quality

Dissolved Oxygen - Laboratory results in the Lower Platte River Basin indicate good stream conditions. Most of the streams had, during the period of study, an average dissolved oxygen content above 5.0 ppm. Salt Creek below Lincoln, and Mud Creek at Broken Bow stand out as the exceptional cases with dissolved oxygen of less than 5.0 ppm. It is well to note that dissolved oxygen results are based upon average computations of the individual results tabulated in appendix G. Critical conditions which can and do exist at times in the streams in the Lower Platte River Basin are not reflected in these averages. Flow conditions at the time of field and laboratory investigations were high. The results obtained serve to indicate that serious pollution conditions occur.

Biochemical Oxygen Demand (B.O.D.) - Figure 8, the B.O.D. map, presents the average range of biochemical oxygen demand, and indicates there are numerous locations where the average B.O.D. may be classified as fairly high to high. B.O.D. is an important indication of the amount of organic matter present in the stream. The greater the magnitude of the organic matter the greater will be the demand upon the dissolved oxygen present in the water. High B.O.D. may also result from surface wash and heavy plankton growth in addition to domestic and industrial wastes.

Coliform Organisms - These organisms are important because of the public health significance attached to their presence in water. Escherichia coli organisms are present in the intestinal discharge of man and animals and their occurrence in waterways may indicate fecal pollution. The coliform group may also be found in soil, on grain in decaying vegetation, and in large numbers when surface runoff occurs. High coliform counts in a stream below a source of pollution, such as a municipality, are more important from the public health viewpoint than a comparable coliform count on a stream draining a watershed with a low and scattered population. Coliform counts provide a most pertinent criteria of pollution.

The Median[1] coliform count on the North Loup River at the water supply intake of Ord is well below the 5000 M.P.N.[2] per 100 ml., which is regarded as the upper average allowable limit for waters to be treated by a rapid sand filtration plant with coagulation, sedimentation and chlorination.

Minerals - The mineral quality of the surface streams varies from satisfactory to poor. The hardness of water runs fairly high

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[1] 50 percent of the results are higher and 50 percent lower than the median value.

[2] Most probable number.

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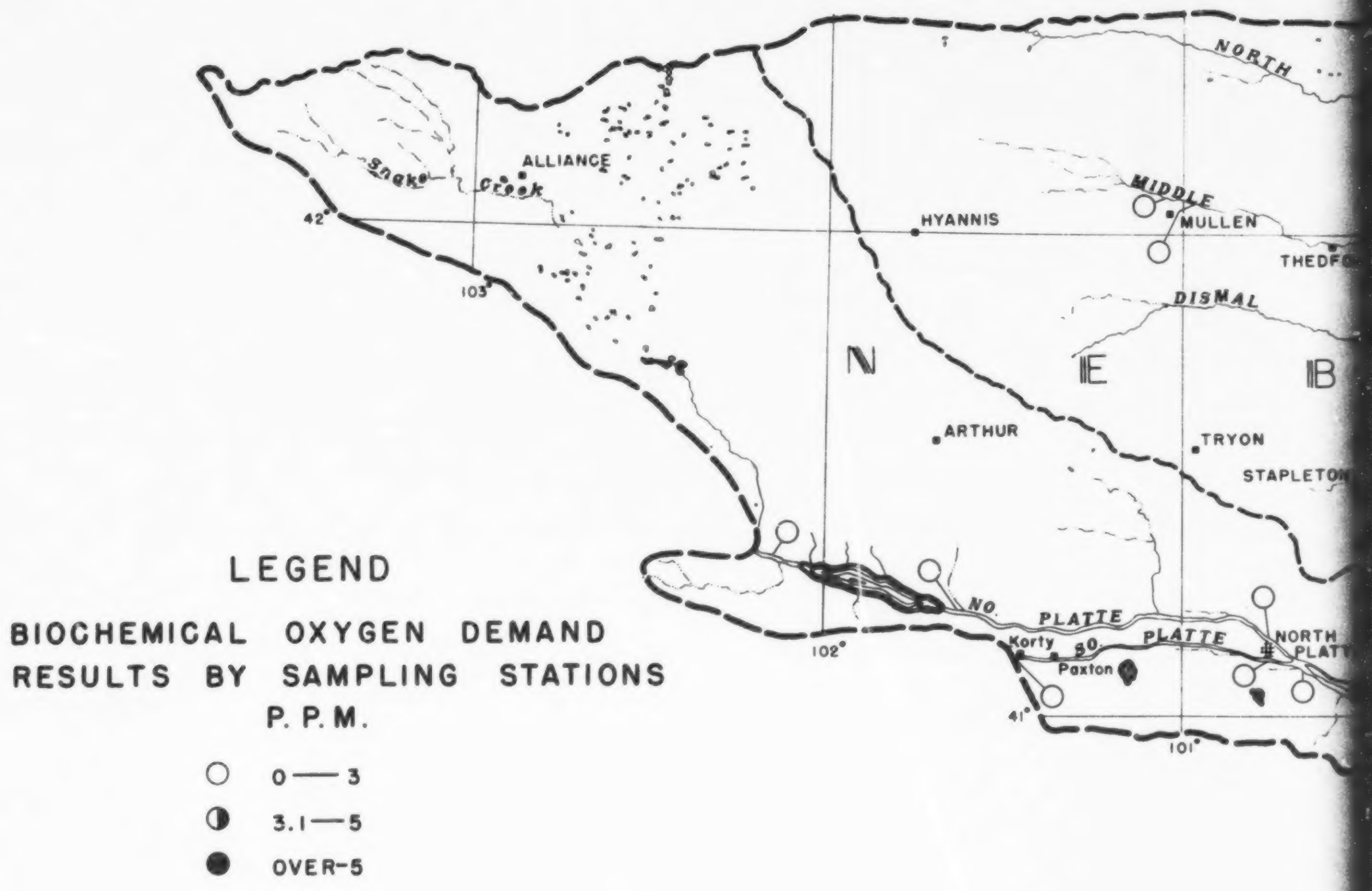
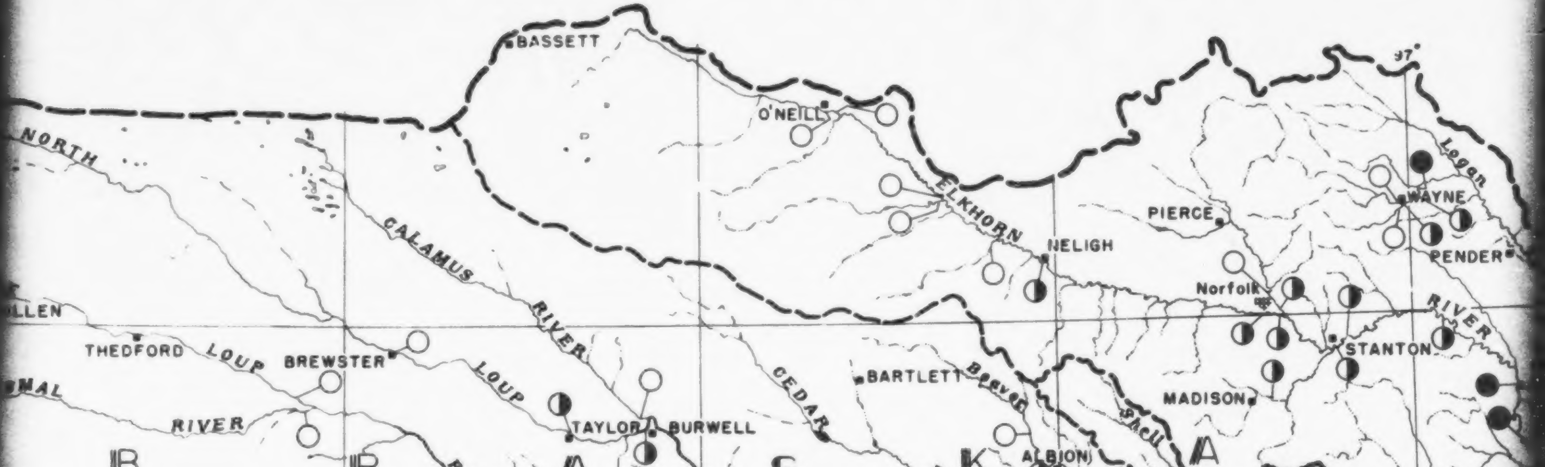


LEGEND

BIOCHEMICAL OXYGEN DEMAND
RESULTS BY SAMPLING STATIONS
P. P. M.

○ 0—3
◑ 3.1—5
● OVER-5

B



LOWER PLATTE RIVE

WATER POLLUTION INVESTIG

APRIL, MAY, JUNE, JULY / 1949

BIOCHEMICAL OXYGEN

AVERAGE RESULT

U.S PUBLIC HEALTH SERVICE

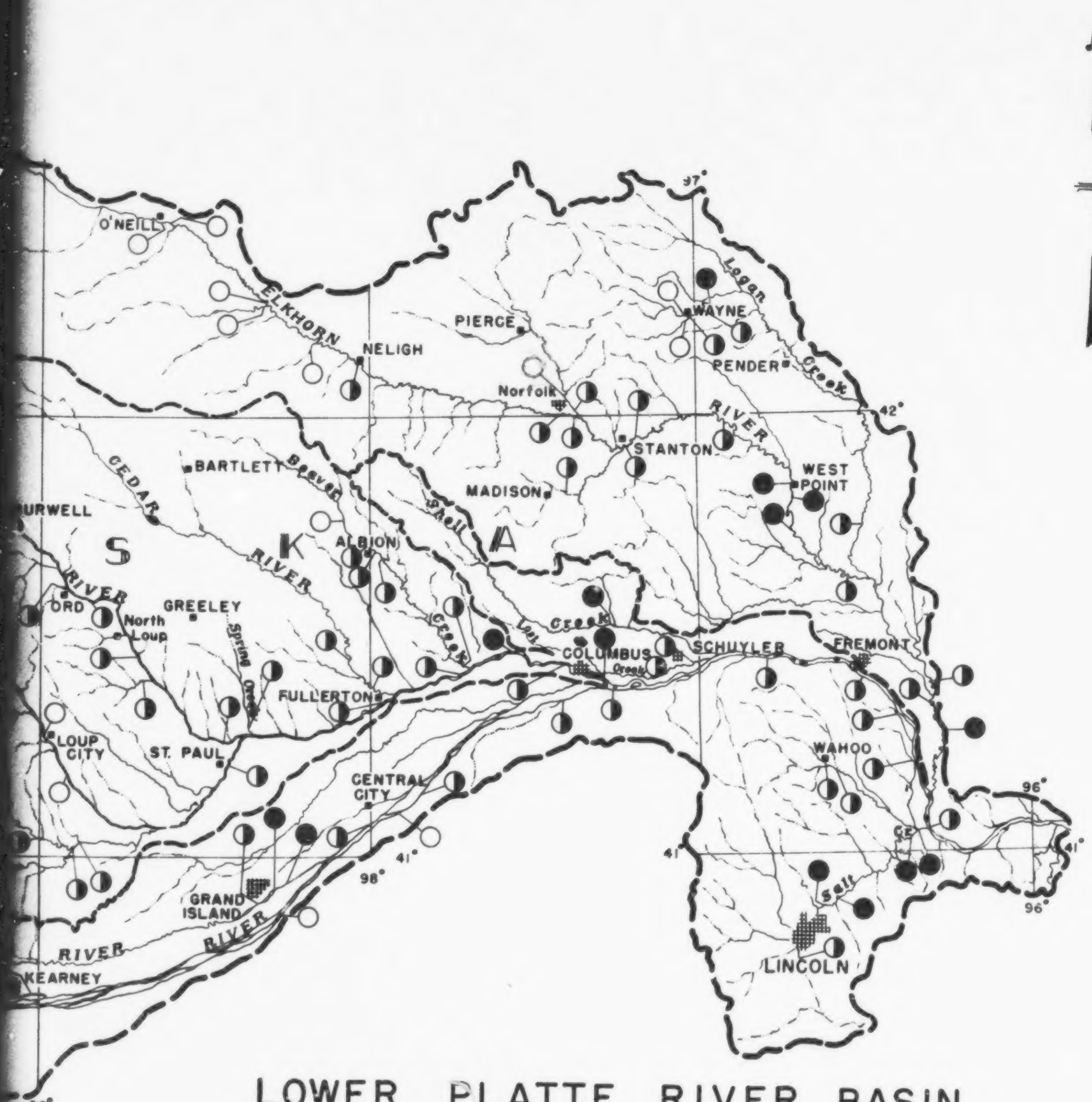
10 0 10 20 30

MILES

46-B

FIGURE 8.

C



LOWER PLATTE RIVER BASIN

WATER POLLUTION INVESTIGATION

APRIL, MAY, JUNE, JULY / 1949

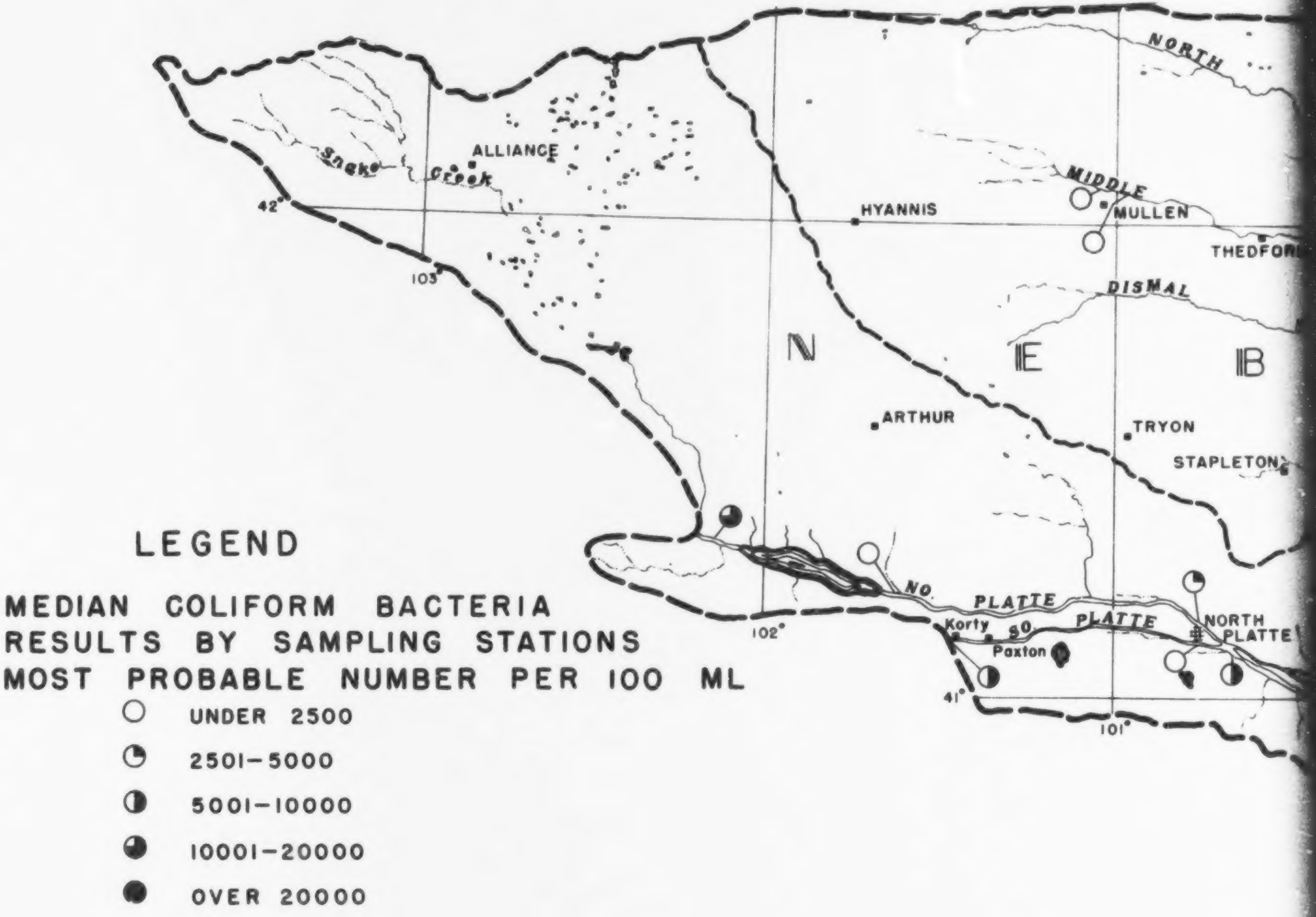
BIOCHEMICAL OXYGEN DEMAND AVERAGE RESULTS

U.S PUBLIC HEALTH SERVICE

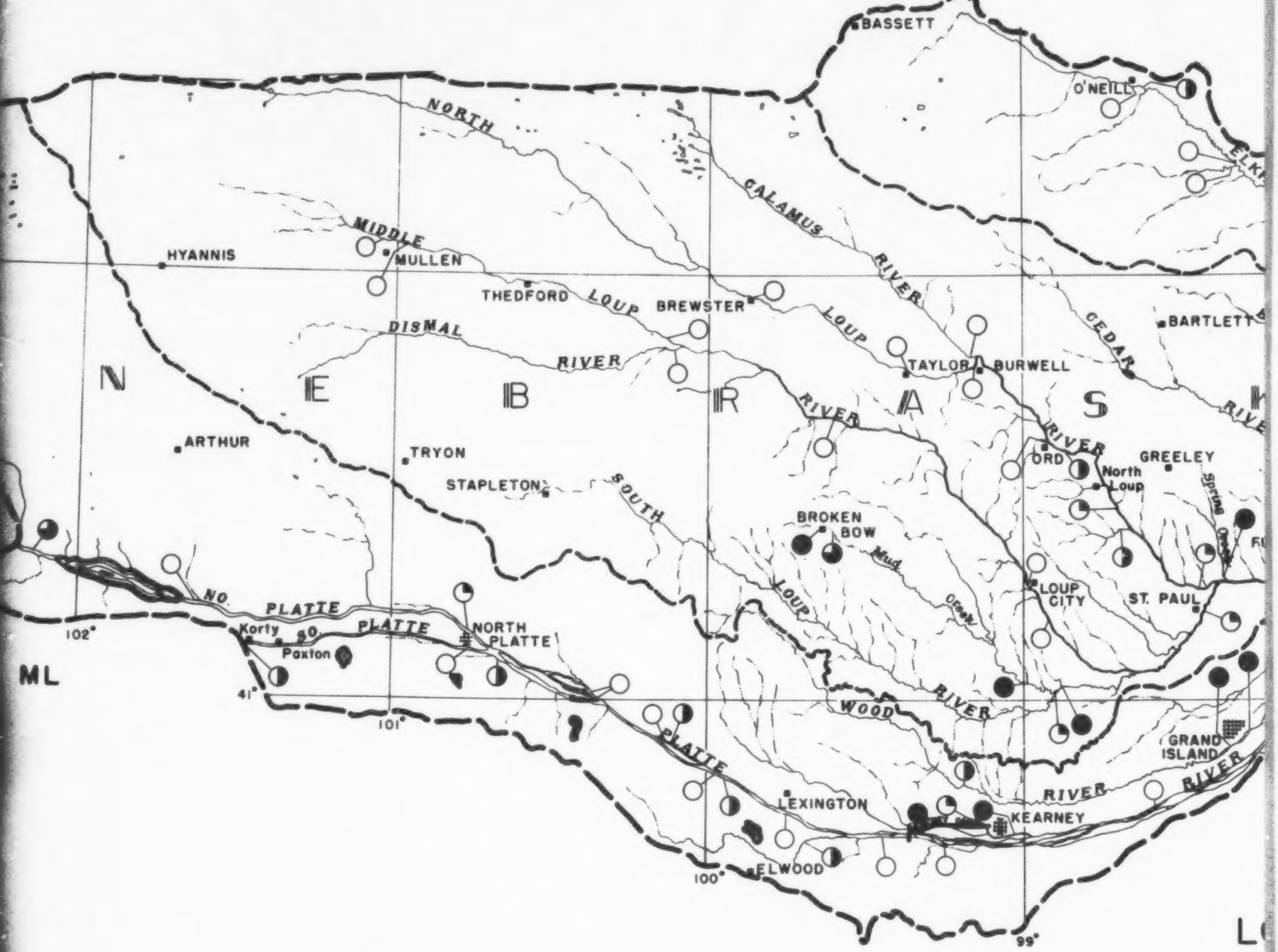
10 0 10 20 30 40

MILES

A


LEGEND
MEDIAN COLIFORM BACTERIA
RESULTS BY SAMPLING STATIONS
MOST PROBABLE NUMBER PER 100 ML
○ UNDER 2500
◔ 2501–5000
◑ 5001–10000
◕ 10001–20000
● OVER 20000
N
E
B
NORTH
MIDDLE
DISMAL
Snake
Creek
ALLIANCE
HYANNIS
MULLEN
THEDFORD
ARTHUR
TRYON
STAPLETON
NO. PLATTE
SO. PLATTE
Korty
Paxton
NORTH PLATTE
42°
103°
102°
101°
41°

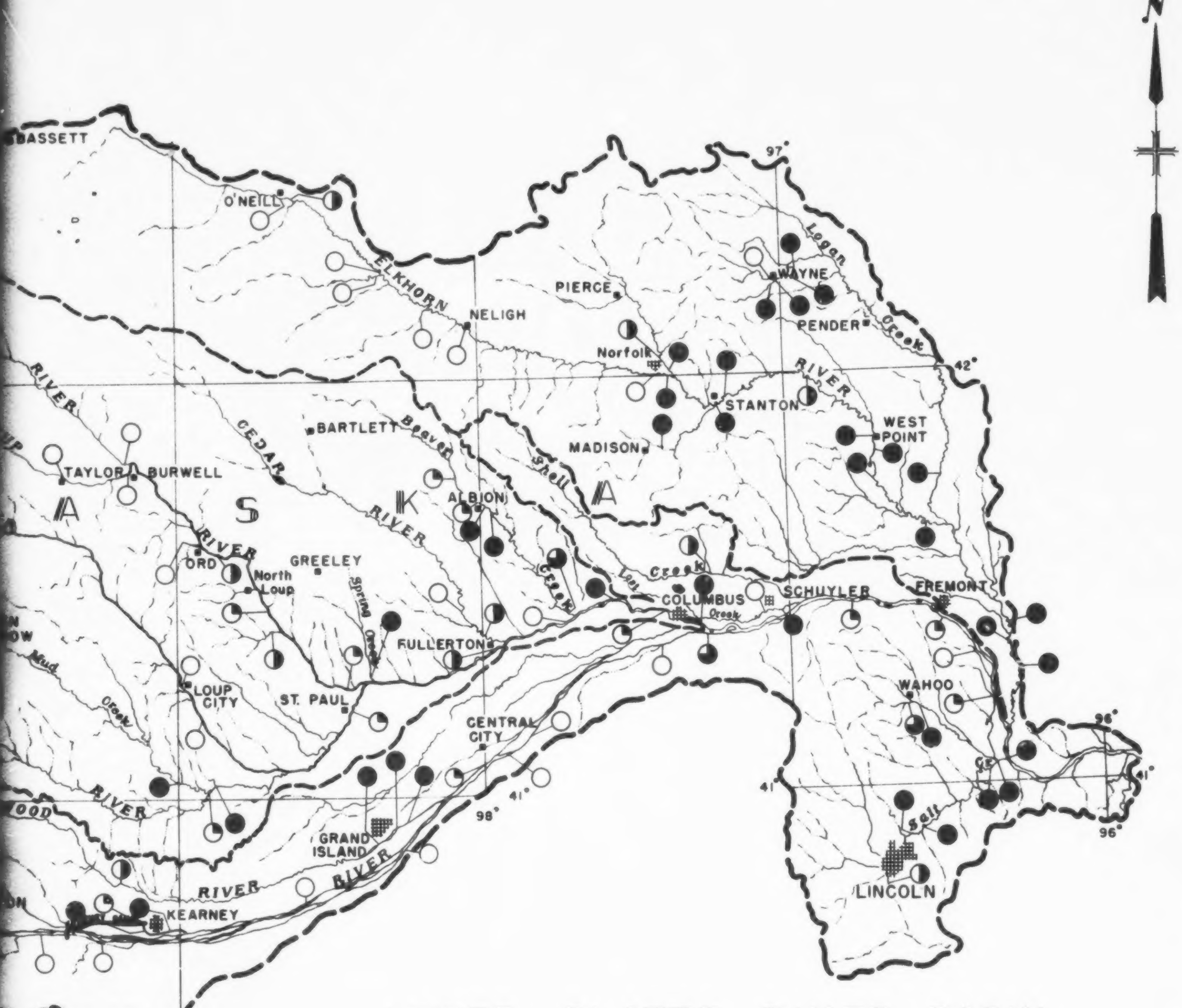
B


BASSETT
O'NEILL
ELK
NORTH
CALAMUS
RIVER
CEDAR
BARTLETT
MIDDLE
MULLEN
HYANNIS
THEDFORD
LOUP
BREWSTER
LOUP
DISMAL
RIVER
TAYLOR
BURWELL
N
E
B
R
A
S
K
RIVER
ARTHUR
TRYON
STAPLETON
SOUTH
RIVER
ORD
GREELEY
North Loup
Spring Creek
BROKEN BOW
Mud Creek
LOUP CITY
ST. PAUL
LOUP
NO. PLATTE
102°
Korty
SO. PLATTE
NORTH PLATTE
Paxton
ML
41°
101°
WOOD
RIVER
GRAND ISLAND
PLATTE
RIVER
RIVER
LEXINGTON
KEARNEY
100°
ELWOOD
99°
LO

46-C

FIGURE 9.

C



LOWER PLATTE RIVER BASIN

WATER POLLUTION INVESTIGATION

APRIL, MAY, JUNE, JULY / 1949

MEDIAN COLIFORM RESULTS

U.S PUBLIC HEALTH SERVICE

10 0 10 20 30 40
MILES

46-C

in the Platte River. Waters of the Elkhorn River and Loup River Basins are low to moderate in hardness. Chlorides in excess of 250 ppm. are found in Salt Creek at Lincoln. Chloride values in other streams in the Basin are low. Reduction in stream flows, because of allotments to irrigation and other uses, would result in a degradation of the mineral qualities of waters in the Basin. Present municipal water supplies are generally derived from ground water sources and would probably not be greatly affected.

Physical Characteristics - Water temperatures vary from freezing during winter months to highs of 77° F. (25° C.) in the summer. Water temperatures influence many important stream sanitation factors. These are discussed briefly in the section entitled "Survey Methods". In addition water temperatures affect aquatic life and are important in municipal and industrial water supplies, particularly where used for cooling purposes.

Turbidity - Turbidity has been found to vary with surface runoff and stream stages. Ranges of less than 10 ppm. during low flow periods to over 24,000 ppm. during periods of high runoff have been recorded.

Color - Color is due to substances in solution and is generally the result of the leaching of organic matter with which the water has come in contact. In general color is not a problem in this Basin. Some discoloration of streams by dissolved impurities and colloidal matter was observed. Industrial wastes were noted to impart coloring matter to tributary streams but duration of this discoloration was generally short.

Tastes and Odors - Taste and odor problems associated with surface water supplies are of minor consequence as Ord, on the North Loup River, is the sole community in the Basin using a surface water supply. Hydrogen sulphide odors related to well waters have been noted elsewhere within the Basin. Hydrogen sulphide waters are noxious to the extent they are odious and distasteful and corrosive to most metals. Waters with 1.0 ppm. or more of hydrogen sulphide are definitely objectionable.

Ord experiences minor taste and odor problems in connection with clean-out operations at the upstream Burwell Diversion Dam. During this short period, additional chlorine treatment is practiced.

Taste and odor control measures usually require additional plant and maintenance capital. Closer control of the water supply is necessary, and the operation of treatment appurtenances becomes more complex.

Other tastes and odors may arise from the development of algal growth. Algae obtain their food materials from soluble nitrogen, phosphorus, potash and other compounds present in surface waters which are subject to pollution with organic matter and possibly return irrigation waters. A heavy propagation of algae is favored by dissolved organic and mineral matter, clear water, sunlight, and quiescent conditions such as may be found in impounded water areas. The reservoirs developed in the Lower Platte River Basin will provide the above factors, and future consideration of this problem will be necessary if public water supply needs require use of impoundments and streams as a source of water.

Ground Water Supplies - With one exception, the communities of this Basin secure public water supplies from ground sources. Supplies are generally adequate and water quality acceptable; iron, manganese, and hardness removal being the principal problems. Chlorination is employed only at infrequent intervals.

Private wells supply inhabitants in rural areas with water for domestic purposes and, in some cases, for livestock watering. Nitrate nitrogen in water supplies, particularly individual wells, has been receiving considerable emphasis in recent years. In 1945 the relationship of nitrate nitrogen to methemoglobinemia in infants was established. This condition has since been recognized to have widespread occurrence and develops following the utilization of waters high in nitrates in concoction of baby formulas. Sanitary surveys of well installations, where methemoglobinemia occurred, usually reveal defects by which contamination such as barnyard runoff may reach the water supply. Yet, this does not preclude the possibility that other means of contamination may occur. Intensive fertilization of irrigated lands may possibly contribute to high nitrate content of well water.

Several states have endeavored to establish some standard regarding the permissible limit of nitrate in potable water supplies. It has been tentatively concluded that 10 ppm. of nitrate nitrogen is the maximum allowable limit and supplies with greater amounts should be viewed with suspicion. A review of this general subject is included as appendix E.

Damage to Water Resources from Pollution

The discharge of untreated sewage to water courses undeniably creates a public health hazard and nuisance. Possible damages that may be suffered are related directly to the uses of the water resources.

Fortunately, the availability of an adequate, potable, ground water supply in this Basin makes most communities independent of surface streams for the vital human need for safe drinking water. Only one community, Ord, in the Loup Sub-Basin, depends upon a surface water supply, and no major sources of pollution are located upstream.

As the development program includes plans for intensified irrigational practices and re-use of surface waters for agricultural purposes, stream pollution increases greatly in importance. Sewage polluted waters will be diverted to lands where contact may be had with low-growing crops consumed raw. The effect is to disperse pathogenic organisms from the relatively restricted water course to possible contact with large segments of the population. A detailed discussion on this subject is presented later in this section.

There is a dearth of fishing and recreation areas and facilities in the Lower Platte River Basin. Because of this the value of suitable locations is greatly enhanced. Angling, mostly for channel catfish, is a common sport in streams of this area. Fishing values developed by the Fish and Wildlife Service have been presented elsewhere. The discharge of organic wastes, if in sufficient quantities as related to stream flow, will seriously depress or possibly deplete dissolved oxygen in the stream, making the environment untenable for fish life. It is reported that fishing in the past was much better than at present, which introduces the possibility that pollution has been detrimental to fish life. Irrigation diversions, which reduce stream flows possibly to zero, may be the important factor.

The streams of the Basin do not lend themselves readily to recreational development. The proposed development program would do much to alter this situation by creating artificial lakes behind storage dams. Pollution may damage these developments particularly where bathing is planned.

Benefits Resulting from Pollution Prevention and Abatement

The Lower Platte River Basin, being predominately rural in character, is studded with numerous small to medium size communities and a few large cities. Sources of pollution are light to moderate and usually are sufficiently far apart to permit at least partial stream recovery. Benefits from pollution prevention and abatement are primarily of local interest and involve protection to public health, prevention of nuisances, and enhancement of general welfare. Fish and wildlife and recreation developments would also derive direct benefits. The control of pollution will do much to protect the bacteriological quality of irrigation waters and safeguard public health. Livestock watered from streams will be protected by the control of pollution.

Pollution Prevention Measures in Effect

Despite limitations resulting from a lack of suitable legal authority and adequate finances for the State Water Pollution Control Agency, Nebraska has a fairly good record in water pollution control and the State Health Department enjoys the confidence of State and city officials and the public at large. Undoubtedly the State program is handicapped by inadequate statutory backing. This matter is presented in detail in the section on legal matters.

Progress of pollution abatement in Nebraska compares favorably with other states in similar situations. Of Nebraska's population served by sewers, 46 percent is tributary to sewage treatment plants. With cities having sewerage systems, 56 percent provide treatment. This compares to 63 percent and 61 percent, respectively, on a national basis. In evaluating progress in pollution abatement it is necessary to consider treatment needs in relationship to water use and stream flows.

Municipalities in Nebraska have shown a cooperative spirit and an understanding of pollution by installing numerous treatment facilities even though the State law is weak. Industry in some instances has done likewise. Existing waste treatment practices are discussed in detail in the various sub-basin sections.

Pollution Prevention Measures Required

The sewage treatment needs and status of proposed projects are listed in table 9. The subject matter is presented according to the designated sub-basins. A delineation of the sewage treatment requirements is discussed in detail in the sub-basin sections.

Considerable progress in pollution abatement has been made. The State Health Department has encouraged the installation of adequate treatment. However, statutory backing with effective law is a definite need and Department activities have been restricted to consultative and advisory activities. Another handicap has been the lack of a sufficient number of engineers on the staff of the Health Department. Present key personnel are experienced and capable but cannot handle unaided the work load throughout the State. The staff assigned to pollution control should be increased and might include district engineers for broad public health work and additional personnel in the central office. With its record of pollution abatement progress under adverse conditions, the Nebraska State Health Department will, no doubt, show excellent progress as public health education is disseminated among the people of the State and recognition of stream pollution needs reflects itself in adequate laws and support.

Laboratory data should be available to the Division of Sanitation and used to complement and supplement sanitary surveys, inspections, and investigations. A mobile laboratory unit would greatly facilitate field activity and provide great assistance in the study of special problems, the evaluation of treatment plants, and in maintaining up-to-date information of stream conditions as established by this and comparable studies completed in recent years.

Communities and industry are cognizant of pollution abatement needs and reflect the educational program of the Health Department. Municipal finance laws apparently do not restrict water pollution progress in Nebraska and many municipalities have already developed

Table 9. Lower Platte River Basin - Sewage treatment requirements and recommendations
Municipalities with over 1,000 sewered population equivalents

Municipality[1]	Remarks	Status[2]
Platte River and Minor Tributaries		
Silver Creek	New plant needed	5
Weston	New plant needed	5
Wahoo	New plant needed	5
Ashland	New plant needed	5
Lincoln	More capacity needed	4
North Bend	Present treatment adequate	1
Newman Grove	New plant needed	5
Schuyler	New plant needed	5
Columbus	Plant obsolete: new plant needed	5
Central City	New plant needed	2
Grand Island	Additional capacity required, expanding existing facilities	2
Kearney	New plant needed	5
Lexington	New plant needed	3
Cozad	New plant needed	3
Gothenburg	New plant needed	3
North Platte	New plant needed	5
Gibbon	New plant needed	5
Louisville	New plant needed	5
Elkhorn River		
Valley	Operation faulty	1
Fremont	New plant needed	5
Clarkson	Improve existing facilities	5
Oakland	New plant needed	5
Lyons	New plant needed	5
Pender	New plant needed	5
Wakefield	New plant needed	5
Winside	New plant needed	5
Wayne	New plant needed	5
Scribner	New plant needed	5
West Point	New plant needed	5
Wisner	New plant needed	5
Stanton	New plant needed	5
Madison	New plant needed	5
Pierce	New plant needed	5
Norfolk	New plant needed	5
Neligh	New plant needed	5
O'Neill	New plant needed	5
Atkinson	New plant needed	5
Tilden	New plant needed	5
Pilger	New plant needed	5
Beemer	New plant needed	5
Snyder	Improve existing facilities	5
Howells	Improve existing facilities	5
Humphrey	Improve existing facilities	5
Leigh	Improve existing facilities	5
Dodge	Improve existing facilities	5
Loup River		
Dannebrog	New plant needed	5
Genoa	New plant needed	5
Albion	New plant needed	5
Fullerton	New plant needed	5
Ord	New plant needed	5
Burwell	New plant needed	5
St. Paul	New plant needed	5
Ravenna	New plant needed	5
Broken Bow	Expansion of existing facilities needed	5
Loup City	New plant needed	5
Cedar Rapids	New plant needed	5
St. Edward	New plant needed	5
Spalding	New plant needed	5

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[1] All municipalities listed are in Nebraska.

[2] Status:
1. Control or plant satisfactory
2. Construction under way
3. Plans approved - finance not arranged
4. Plans or report under way
5. Project needed

plans for treatment works and will proceed with construction as the Department develops a continuing program. This report will outline such needs and may well form a basis for a comprehensive abatement program. The holding of hearings should be considered to obtain opinions, reactions, and the support of the public in such a program. Industry in particular should be invited to participate. Once an overall plan has crystallized, the State Health Department should pursue it with vigor and determination.

Pollution control is especially important in this Basin where surface water use will be extensively developed. The higher the degree of sewage treatment the less stream flow will be required for waste dilution and public health purposes.

Adequate stream flow is vital to the proper assimilation of wastes discharged to water courses. A detailed discussion of this matter is presented later in this section, and recommended minimum flows for various specific locations given in the sub-basin sections. The over-all development program promulgated by the Bureau of Reclamation should include public health consideration in its planning as exemplified by this cooperative study in the Lower Platte River Basin and other Basin investigations. Minimum flows compatible with public health and stream sanitation needs as recommended by this report should be provided if feasible.

Flow and Treatment Requirements

Desirable minimum stream flows are those flows required for the dilution of primary treatment plant effluent. It is assumed that critical pollution conditions will be corrected by State action prompted by an interest in maintaining optimum stream conditions because of the public health aspect, or because nuisance conditions have led to legal action. These conditions can be alleviated by the installation of treatment plants designed to relieve the pollutional load discharged to the stream. The degree of treatment required will depend upon the nature and site of the contributed waste and the flow conditions encountered. Primary treatment for the removal of settleable solids and floating matter is regarded as a minimum requirement. When minimum flows are below the limit required for the dilution of primary treatment plant effluents secondary treatment is necessary. Secondary treatment desirable flows have been calculated on the assumption that sewage and industrial wastes receive secondary treatment and therefore require less dilution for the assimilation of the residual pollution.

This study indicates generally normal stream deoxygenation. It was observed that the rate of reoxygenation was high, for low flows, during the period of study. Critical flows have been established at various locations, based upon man-made pollution, with a relatively minor allowance for surface wash or natural pollution. Natural pollution may be an important item in the Lower Platte River Basin.

However, at low flows, its effects are minimized and sources of man-made pollution become the major factor in the determination of treatment requirements at critical flows. Surface wash is difficult to evaluate because of the numerous elements which combine to present an additional pollutional problem to the stream. Various characteristics of the watershed and its uses are implicated; among these are location, size, shape, slope, and surface conditions such as cover and perviousness of soil. The type of area, such as urban or rural, and classification of farming methods used, such as natural or artificial fertilization practices, are important. The principal interest is in stream behavior during minimum flows at which time there is little or no surface wash pollution. Therefore estimates of sewage treatment requirements have been based upon minimum flow conditions with a relatively small allowance for natural pollution.

Utilization of impounded waters for purpose of dilution is subject to a number of complicating factors. In the summer, or low flow period, stream discharge may be lost to the atmosphere by evaporation, may be diverted for irrigation uses, and may, in some streams, percolate to ground water. Discharges at the tailrace of headwater impoundments could be materially reduced by the time the point of pollution was reached. Evaluations of flow have not included the above factors and are considered as the stream discharge for effective dilution at the point of pollution.

The return of irrigation waters may provide the minimum desired flows at certain times of the year. However, in order to achieve a beneficial value from return flows, it will be necessary that they, supplemented by any other flows, provide the minimum recommended stream flows throughout the year.

Greater stream flow is required in periods of high water temperature than at times when the water temperature is low. Table 10 indicates a typical month-to-month variation in flow needs, with June, July, August, and September representing the 100 percent flows.

Table 10. Lower Platte River Basin - Average temperatures and seasonal variations of desirable minimum monthly mean flows.

Month	Approximate Average Stream Temperature[1]		Average Air Temperature[2]		Minimum Monthly Mean Flow as Percent of Summer Season Flow[1]
	°F	°C	°F	°C	
January	34	1	23	-5	20
February	34	1	26	-3	20
March	37	3	36	2	25
April	54	12	49	10	40
May	66	19	59	15	60
June	72	22	69	20	100
July	81	27	75	24	100
August	79	26	73	23	100
September	75	24	64	18	100
October	59	15	51	11	45
November	48	9	37	3	30
December	36	2	27	-3	20

---

[1] From Report of Kansas River Basin Water Pollution Investigation June 1949.

[2] Average temperatures for State of Nebraska--73-year record, U. S. Weather Bureau.

Recommended Flows - It is recommended that flows classified as useful desirable minimums be maintained, whenever possible, by a flow regulation program. These flows are founded upon a minimum D. O. objective of 5.0 ppm., which is a necessary oxygen level for the maintenance of a balanced aquatic life, and upon a minimum of primary treatment of sewage wastes. Other factors such as depth of water and cross-section of stream affect the habitat of fish and should receive consideration. Flow estimates are based upon existing pollution, and suitable adjustments must be made when future growth warrants. Desirable flows as suggested in this report provide for the minimum sanitation needs of the stream. In event higher uses of the stream develop, a greater degree of sewage treatment or increased minimum stream flows may be resorted to.

Minimum Flows - The foregoing discussions deal with flows which are desirable. In fortunate locations the normally expected unregulated minimum flow is more than adequate to assimilate partially treated sewage without a serious oxygen depletion; this is the case in numerous locations in the Basin. Normal minimum monthly mean flows are those flows that occur at such periodic frequencies as to form a firm base for treatment design. At other locations the minimum flows, which may frequently approach zero, are insufficient to assume pollution loads without the highest possible degree of sewage treatment.

Table 10. Lower Platte River Basin - Average temperatures and seasonal variations of desirable minimum monthly mean flows.

Month	Approximate Average Stream Temperature[1]		Average Air Temperature[2]		Minimum Monthly Mean Flow as Percent of Summer Season Flow[1]
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May	66	19	59	15	60
June	72	22	69	20	100
July	81	27	75	24	100
August	79	26	73	23	100
September	75	24	64	18	100
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Experience has shown that even with the highest degree of treatment, a stream with no flow above the point of pollution cannot reliably be maintained in a satisfactory condition. However, such periods of zero or extremely low flow are normally infrequent and of relatively short duration. It is not sufficient, therefore, to maintain minimum flow conditions by regulation on the assumption that the resulting stream would be no worse than prior to reservoir and irrigation development. Actually, the stream would be in worse condition practically all of the time, and would be no worse only at times of normally expected unregulated low flow.

Treatment Requirements - Present treatment requirements were based upon normal minimum flow expectancies. If these minimum expected flows are raised by the flow regulation program, benefits to the cities may result in the form of a lower required degree of treatment. On the other hand, if present minimum expected flows are reduced by such a program the cities may be damaged to the extent that a higher degree of sewage treatment may be necessary to maintain satisfactory oxygen conditions in the stream. Where studies indicate that the basic minimum--primary treatment--requirement for all cities is adequate at present minimum flows there can be no benefits ascribed to increased minimum flow levels by regulation. Results of these studies are presented in the sub-basin sections of the report.

Natural Self-Purification - The self-purification capacity of a stream is estimated in order to ascertain the amount of pollutional load the stream can assimilate without serious impairment of its dissolved oxygen level. An economical degree of sewage treatment can then be selected to meet requirements as derived from the self-purification capacity.

The dissolved oxygen level in any stream is dependent upon the relation between deoxygenation and reoxygenation in that stream. Deoxygenation represents the effects of oxygen depletion, while reoxygenation is oxygen replenishment, and the resultant oxygen concentration in the flowing stream will depend upon which effect is predominant.

The extent of deoxygenation in the flowing stream is influenced mainly by the concentration of organic pollution, time of flow and temperature. The rate of reoxygenation is affected by the oxygen deficit below saturation, temperature, time, and hydraulic factors such as stream depth and the extent of mixing or turbulence. Dissolved oxygen income from the photosynthetic action of algae is influenced by sunlight and turbidity, in that sunlight is necessary for photosynthesis, while turbidity reduces the water depth to which sunlight will penetrate. In streams of the Lower Platte River Basin turbidity may be relatively high at high stream flows and low at drought flows. At low flows, therefore, algae may represent a source of appreciable oxygen income.

Stream self-purification may be materially affected by the installation of a stream barrier, or dam. The velocity of flow through the reservoir behind a dam is often quite low, resulting in a long time of flow. This results in deposition of a portion of the organic pollution load, and a higher percentage of the flowing load is exerted over the relatively short mileage of the reservoir. The slower velocities reduce mixing and therefore reaeration, but the quiescent conditions are favorable to algal growth and photosynthesis. At the slower velocities suspended matter will be deposited, and turbidity is no longer an important inhibitor of photosynthesis. Finally, the passage of water over the tailrace and spillway results in greater mixing and increased reaeration income.

Benefits and Damages Attributable to Flow Regulation Program

Desirable stream flows at various locations in the Basin have been estimated and are based upon a minimum D.O. objective of 5.0 ppm., and primary treatment as a basic minimum requirement for all wastes. Secondary treatment has been considered where stream conditions and water use indicate the need for such treatment. Refinement beyond primary treatment represents a substantial financial investment and introduces possible benefits where stream flow can be increased to permit satisfactory operation with primary treatment only, thereby effecting a sizable saving in initial plant cost as well as in operation, maintenance, and replacement. This saving is considered a direct benefit from the increase in stream discharge. Such benefit can reach considerable proportions when a river receives the discharges of many communities and industries.

Benefits that may result from various flow situations have been assigned a monetary value based upon estimated annual costs of primary and secondary treatment of sewage for certain communities. Per capita costs of treatment plant construction, based upon the size of city and degree of treatment have been varied according to need. These costs are derived from cost date in this area. Initial costs have been expressed as annual charges based upon a 20-year life and a 4 percent interest rate. Annual per capita costs of operation and maintenance, also based on size of city and degree of treatment, have been included.

Primary treatment is inadequate for those cases having a normally expected minimum monthly average flow less than the desirable flow, and a higher degree of treatment is required. In this case primary treatment would be adequate contingent upon a regulation program to provide a minimum monthly average flow equal to or greater than the desirable flow. Benefits would result in the form of savings due to a required lower degree of treatment. No benefits are possible when the normally expected minimum flow is equal to or greater than the desirable flow corresponding to primary treatment.

Where the normally expected minimum monthly average flow is equal to or greater than the desirable flow primary treatment may be adequate. Should the flow regulation program provide a minimum flow less than the desirable flow, a higher degree of treatment will be necessary which will result in increased costs to the city. However, no damages exist when the regulated flow is greater than the desirable flow, even though it represents a reduction of the normally expected minimum flow.

Flow Requirements for Future Populations

The development plan of the Lower Platte River Basin is a long range program and evaluations of water use encompass a considerable length of time. Future flow requirements for water supply and sanitation would be of importance to the construction and operating agencies in the development of the program. The Bureau of Reclamation, in its analysis of this area, has estimated a population growth over the next 50 years to be about 10 percent. This increase is based upon the present density of population which is considered to be quite high as compared to average rural areas.

An evaluation of the sewered population equivalent that might be discharged to streams at a future date has been considered to be based upon the following factors: (a) sewered population in the metropolitan areas will increase approximately 20 percent; (b) there will be a net population increase of about 10 percent; (c) industrial activity will increase the amount of pollution contributed from this source by 10 percent. Thus the present loading may increase approximately 40 percent, which is a reasonable expansion of population and industry compatible with the development program.

It is also reasonable to assume that, over the 50-year period, the efficiency of sewage treatment and sewage treatment equipment will improve, especially as influenced by proper operation. The assumption is made that future treatment, possibly with additional treatment refinements, may increase the removal of pollution over the present assigned dependable values by possibly 10 percent. Dependable secondary treatment efficiencies of 85 percent have already been achieved.

Using the assumed conditions as given above, it is found that the desirable flows based on primary treatment of sewage may be increased approximately 20 percent during the next 50 years. Similarly, flows required for secondary treatment 50 years hence may be substantially the same as present needs.

However, there may be numerous instances where excessive population growth and significant industrial development will exceed the estimated increments. In these cases a substantially greater pollutional load may be placed upon treatment facilities and the receiving streams. As it is impossible at the present time to clearly evaluate these conditions, recourse to study of these individual problems as they occur will be necessary. It appears that the present flows designated as desirable would suffice for conditions encountered during the foreseeable future, and that probable improvements in treatment efficiencies would provide for pollution increments normally anticipated. Special conditions, such as the development of additional industrial activity, establishment of a new industry, or large increases in population, would necessitate a special study of the area concerned.

Public Health Aspects of Polluted Irrigation Waters

The comprehensive development plan of the Basin includes extensive irrigation projects. The health aspects of irrigation waters are sufficiently important to warrant inclusion in this discussion.

Significant public health problems arise with the use of sewage polluted irrigation waters. At the present time there does not exist a completely reliable yardstick for the measurement of hazards under specific conditions. Although some health departments (appendix D) have promulgated standards, no single generally applicable standard, such as those available for drinking water, has been developed for the sanitary quality of irrigation waters. The principal lack of information lies in the field of epidemiology. Reliable data may be available at the conclusion of studies now under way, and the development of standards must await the outcome of epidemiological investigations in addition to more conclusive bacteriological studies of the use of polluted irrigation waters in connection with irrigated lands and crops. Appendix D contains a partial review of the literature on health hazards associated with irrigation, and suggests that the use of polluted irrigation waters may be responsible for a number of diseases. An important consideration is the type of crop irrigated. Low-growing fruits and vegetables, such as celery, cabbage, carrots, and strawberries, which are often consumed raw, offer the most serious hazard. Of less significance are field crops, such as corn. Possible hazards to livestock, particularly dairy cattle, must receive consideration. Farm water supplies may be adversely affected in some cases.

Irrigation with sewage polluted water has the effect of removing polluted water from points of only limited access, such as streams, and distributing the pollution over a much larger area where it may come into contact with fruit, vegetables, grains, and livestock, depending upon the local irrigation situation. The consequence in terms of the probability of the transfer of infectious material from a diseased host to a healthy person or animal must not be overlooked.

The sanitary survey--the locating of points of potential danger--is of great importance in any stream sanitation study. This report presents detailed information on the sources of pollution. Analyses of irrigation waters must be interpreted in the light of such survey findings. For example, the presence of coliform organisms in a headwater stream, even in large numbers, is less significant than when these same organisms are noted below a known sewer outfall. The time factor is of importance also. A small amount of pollution near the point of irrigation water use may, from a health standpoint, have much more significance than a much higher pollution load discharged into the stream a considerable distance away. This is true because bacterial contamination is rapidly reduced in a flowing stream. Storage in reservoirs generally has the effect of increasing the time of flow from a point above the reservoir to one below, thus contributing to the destruction of large numbers of bacteria.

Sewage treatment processes remove large numbers of bacteria, but the usual municipal sewage treatment plant is not designed nor operated to produce an effluent free from bacteria or other organisms pathogenic to man. Chlorination as a method of disinfection is employed to reduce the pathogenic organisms and total coliform count. Chlorination is not generally practiced at sewage treatment plants in the Basin. The same statement applies to the majority of sewage treatment plants in the United States. The approximate efficiency of various treatment processes as far as bacteria removal is concerned is shown in table 11.

Table 11. Lower Platte River Basin - Bacterial efficiency of various sewage treatment processes[1]

Type of Treatment	Percent Removal of Bacteria
Primary Treatment	25 - 75
With chlorination	90 - 95
Chemical Precipitation Treatment	40 - 80
Secondary Treatment	
Complete trickling filter plant	90 - 95
Activated sludge plant	90 - 98
Intermittent sand filtration plant	95 - 98
Any of the above with chlorination	98 - 99

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[1] Imhoff - Fair, Sewage Treatment, p 6 (John Wiley & Sons, 1940).

In summary, it may be said that:

(a) The use of sewage polluted irrigation water presents a public health hazard.

(b) No applicable standards for the sanitary quality of irrigation water are available at present. Research on this problem is now in progress.

(c) In interpreting the results of bacterial analyses of irrigation waters, careful consideration must be given to sanitary survey data.

(d) Sewage treatment practice in the Basin removes large numbers of bacteria but plant effluents cannot be considered free from pathogenic organisms.

PLATTE RIVER AND MINOR TRIBUTARIES

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PLATTE RIVER AND MINOR TRIBUTARIES

SUMMARY

The main Platte River Valley extends across the central part of the State of Nebraska. The Platte River flows generally eastward from the confluence of the North and South Platte Rivers approximately five miles east of the City of North Platte, and finally discharges into the Missouri River in the vicinity of Plattsmouth. Rainfall varies from 28 inches at the Missouri River to about 18 inches in the western extremities of the Basin. The economy is based upon agriculture and related products. Irrigation has been practiced in the Basin since the latter part of the nineteenth century and at the present time both gravity and pump irrigation methods are used singly or in combination. Municipalities use ground sources for public water supplies and generally discharge domestic and industrial wastes to surface streams. Throughout the Basin some public health hazards and nuisances have occurred wherever untreated sewage and industrial wastes are discharged. During summer periods stream flows diminish greatly and often approach zero. A minimum of primary treatment of wastes is the requirement for all municipalities. Secondary treatment is needed where local nuisances and low stream flows prevail. Nine major existing reservoir and diversion structures are in operation, and there are 10 major reservoir and diversion dams proposed for the Basin. The regulation of stream flow will affect stream sanitation and public health. Caution is advised in the irrigation of truck crops consumed raw with water polluted with sewage wastes until satisfactory standards governing the utilization of such waters have been developed from investigatory studies now under way. Chlorination of sewage plant effluents may be indicated. Stream sanitation conditions will be impaired if a reservoir operation program results in flows less than that required for public health purposes. Desirable flows are presented in table P-9 of the text.

CONCLUSIONS

1. There are no municipal surface water supplies in the main Platte River Basin.

2. Fifty-eight municipalities obtain their water supplies from ground sources to supply a population of 179,885 with 30.74 million gallons daily.

3. A population of 166,590 is connected to sewers; industrial wastes account for an additional 103,965, or a total of 270,555 population equivalents. This total sewered population equivalent is reduced by treatment to 168,425. Municipal sewage treatment plants handle 174,830, or 64 percent, of the total sewered population

equivalents; 72,600 population equivalents, or 41 percent, are discharged untreated to streams.

4. Major structures in the Basin include five existing and seven potential storage and regulating reservoirs, and four existing and three potential diversion structures.

5. New sewage treatment plants or improvements to existing plants are required at 17 municipalities.

6. Desirable flows in order to fulfill sanitation needs are indicated in table P-9 and are based upon a minimum of primary treatment for all municipalities.

7. Table P-9 lists the tangible annual monetary benefits attributable to the regulation program if desirable minimum flows are provided.

8. Caution must be exercised in the use of polluted waters for irrigating crops growing close to the ground and which may be consumed raw. Chlorination of sewage treatment plant effluents for the control of pathogenic organisms may be indicated.

DESCRIPTION

The Platte River, formed by the confluence of the North and South Platte Rivers about 5 miles east of the City of North Platte, is located entirely within the State of Nebraska and flows east about 310 miles to its junction with the Missouri River near Plattsmouth. The river is a broad, sandy, shallow stream studded with many islands, and generally acts as a great interceptor. Only two significant minor tributaries flow into the Platte River from the south while several major tributaries originate in the great Sand Hill region to the north. Percolating waters from the water table reservoir of the Sand Hill area supplement the flows from these tributaries. Table P-1 lists the principal minor tributaries.

Table P-1. Platte River and Minor Tributaries - Tributaries and their drainage areas.

Stream	Miles above Platte River mouth	Drainage area square miles[1]
Platte River		
Salt Creek	26.4	1,606
Shell Creek	83.5	560
Prairie Creek	119.0	641
Wood River	161.4	715
Elm Creek	231.4	386
Plum Creek	245.6	289

[1] Date from Platte River Report - House Document No. 197, 73rd Congress Second Session, Corps of Engineers.

Population growths of 82 communities in this valley are depicted in table P-2. Eight cities have populations of 5,000 or more including Lincoln, the State Capitol, with 115,000; Grand Island, 25,000; North Platte, 18,000; Fremont, 16,000; Kearney, 12,500; Columbus, 9,300; Lexington, 5,200; and Plattsmouth, 5,000. The preponderance of the remaining municipalities have less than 500 inhabitants.

The economy of the Basin is founded upon agriculture and associated products. Corn, wheat, sugar beets, and livestock are the principal farm crops, and food processing is the main industry activity.

Climate in the eastern end of the main Platte Basin varies from humid to subhumid. Progressing westward it changes to semiarid in mid-Nebraska. Precipitation at the Missouri River averages about 28 inches annually and decreases gradually to about 18 inches in the west; the gradation is remarkably uniform, averaging about 1 inch less precipitation from east to west for each 25 miles. Temperatures are characterized by their extremes of -40° F. to over 100° F.

RESERVOIRS AND DIVERSION DAMS[1]

Table P-3 lists seven potential and five existing reservoir projects according to data provided by the Bureau of Reclamation

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[1] The words proposed and potential are used interchangeably. In conformance with the intent of the Comprehensive Plan of the Lower Platte River Basin of the Bureau of Reclamation, both should bear the portent of the word potential.

Table P-2. Platte River and Minor Tributaries - Population of municipalities

Municipality[1]	Population - U. S. Census			
	1920	1930	1940	1949 (Est.)
Abie	132	196	134	130
Alda	-	153	151	150
Amherst	259	262	238	240
Arthur	-	-	142	150
Ashland	1,725	1,786	1,709	1,900
Bellwood	369	391	434	450
Brady	400	387	460	475
Brainard	468	400	444	460
Bruno	245	202	189	200
Cairo	427	425	411	620
Cedar Bluffs	516	517	504	525
Central City	2,410	2,474	2,460	3,000
Ceresco	398	391	342	360
Chapman	224	283	204	235
Clarks	540	540	454	465
Cozad	1,293	1,813	2,156	4,000
Davey	123	154	125	130
Denton	145	114	126	125
Doniphan	482	436	395	400
Duncan	182	241	241	250
Dwight	309	323	294	300
Eddyville	227	224	237	240
Elm Creek	600	708	730	750
Elwood	473	509	633	680
Eustis	434	497	459	500
Farnum	408	394	346	350
Firth	332	322	323	330
Fremont	9,592	11,407	11,862	16,000
Funk	147	117	120	125
Gibbon	883	825	836	845
Gothenburg	1,754	2,322	2,330	3,000
Grand Island	13,947	18,041	19,130	25,000
Greenwood	340	404	350	360
Hershey	482	473	487	498
Hickman	380	302	320	320
Ithaca	156	137	139	140
Kearney	7,702	8,575	9,643	12,500
Leshara	102	110	84	80
Lexington	2,327	2,962	3,688	5,200
Lincoln	54,948	75,933	81,984	115,000
Lindsay	490	456	332	350
Linwood	297	235	247	250
Louisville	645	969	977	1,000
Malcolm	125	121	121	125
Malmo	189	179	167	170

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[1] See footnote at end of table.

Table P-2. Platte River and Minor Tributaries - Population of municipalities--Continued

Municipality[1]	Population - U. S. Census			
	1920	1930	1940	1949 (Est.)
Maxwell	410	409	480	480
Mead	329	310	260	300
Memphis	186	149	103	125
Miller	223	263	205	200
Morse Bluff	216	179	170	175
Newman Grove	1,260	1,146	1,036	1,200
North Bend	1,087	1,108	1,003	1,200
North Platte	10,466	12,061	12,429	18,000
Octavia	-	142	151	150
Overton	515	600	491	500
Paxton	430	507	551	570
Platte Center	464	525	509	509
Plattsmouth	4,190	3,793	4,268	5,000
Prague	353	421	385	482
Raymond	249	205	199	200
Richland	133	174	160	165
Riverdale	-	129	121	152
Roca	133	107	127	140
Rogers	128	138	121	125
Schuyler	2,636	2,588	2,808	3,200
Shelton	1,037	927	983	1,000
Silver Creek	583	464	421	450
Smithfield	229	165	158	160
South Bend	143	99	100	100
Sprague	112	135	121	125
Springfield	413	419	370	385
Sumner	345	297	296	300
Sutherland	651	753	862	948
Tarnov	128	82	98	100
Valparaiso	599	523	403	450
Wahoo	2,338	2,689	2,648	3,500
Waverly	334	315	306	325
West Lincoln	162	264	277	285
Weston	372	365	371	375
Wood River	820	751	829	850

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[1] All municipalities listed are in the State of Nebraska

Table P-3. Platte River and Minor Tributaries - Reservoir data[1]

		Miles to mouth					
				Acre-Feet of Capacity			
Reservoir	Tributary stream	Platte River	Tributary stream	Active	Inactive	Total	Status[2]
Shell Creek	Shell Creek	83.5	10.4	100,000	15,000	115,000	P
Bellwood	Clear Creek	109.0	24.2	37,000	2,000	39,000	P
Cairo	Dry Creek	157.0	8.7	15,000	3,000	18,000	P
Amherst	Wood River	178.5	64.0	300,000	8,000	308,000	P
Bison	Buffalo Creek	231.4	32.6	126,000	7,000	133,000	P
Bertrand	-	240.0		10,000	0	10,000	P
Plum Creek	Plum Creek	245.6	4.2	294,000	10,000	304,000	P
Johnson	Platte River	253.0		36,000	16,000	52,000	Re
Jeffrey	Platte River	292.5		7,000	5,000	12,000	Re
Kingsley	N. Platte River	309.8	54.7	1,948,000	0	1,948,000	Ex
Maloney	S. Platte River	309.8	1.2	19,000	3,000	22,000	Re
Sutherland	S. Platte River	309.8	23.4	50,000	5,000	55,000*	Ex

[1] Data from Bureau of Reclamation
[2] Status - Ex - Existing
P - Potential
Re - Existing regulating
*Seepage limits storage to 55,000 acre-feet. Potential improvements will increase storage to 100,000 acre-feet.

Table P-4. Platte River and Minor Tributaries - Diversion dam data[1]

		Miles to Mouth				
				Water Diverted		
Diversion Dam	Tributary	Platte River	Tributary Stream	From	To	Status[2]
Columbus		102.0		Platte River	Shell Creek via Schuyler Canal	P
Wood River	Wood River	161.4	70.5	Wood River	Buda Canal Wood River Canal	P
Lexington		250.0		Platte River	Amherst Feeder Canal	P
Brady		289.5		Platte River	Gothenburg Canal Gothenburg Highline Canal	Ex A P
Maxwell		309.0		Platte River	Jeffrey Supply Canal	Ex
Keystone	North Platte River	309.8	54.5	North Platte River	Sutherland Supply Canal	Ex
Korty	South Platte River	309.8	42.3	South Platte River	South Platte River Feeder Canal	Ex

[1] Data from Bureau of Reclamation
[2] Status - A - Abandonment
Ex - Existing
P - Potential

(figures 1 and 2, General Section). Three major diversion dams have been proposed to complement the existing four diversionary structures (table P-4). Rehabilitation of the diversion dam at Brady, which diverts water to the Gothenburg Highline Canal, has been recommended.

Existing Dams

Lake McConaughy (Kingsley Dam), the largest existing storage unit in the Basin, with a normal capacity of 1,948,000 and a maximum of 2,356,000 acre-feet, was constructed for the primary purpose of providing irrigation water. Below Lake McConaughy, Keystone Diversion Dam directs water to the Sutherland Reservoir by Sutherland Supply Canal; the remainder of Lake McConaughy water flows down the North Platte River and is utilized for irrigation through extensive canalization possessing water rights acquired during the period 1880-1900 (figure 2 - General Section). Keith and Lincoln Counties Canal diverts water from the south bank of the North Platte River southeast of Keystone. Sheridan-Wilson Canal receives water from the North Platte near Paxton and extends eastward. North Platte Canal diverts water from the North Platte River northwest of Sutherland and returns waste water to the river north of the City of North Platte. The Paxton-Hershey Canal diverts from the south bank of the North Platte River northwest of Sutherland and wastes into the North Platte Canal northwest of Hershey. The Suburban Canal diverts water at the south side of the North Platte River northwest of Hershey and extends eastward beyond North Platte. The Cody-Dillon Canal receives water from diversions northwest of the City of North Platte. The present canal travels eastward and returns waste water to the main stream north of North Platte.

Sutherland Reservoir was originally designed to store 174,000 acre-feet of water but because seepage losses have reduced normal storage to about 55,000 acre-feet, plans are being made to improve the existing structure so that 100,000 acre-feet will be available for downstream uses. Outflow of Sutherland Reservoir passes to Maloney Regulating Reservoir, which in turn discharges to the North Platte Power Plant and is returned to the South Platte River at North Platte.

East of the City of North Platte and below the confluence of the North and South Platte Rivers, Maxwell Diversion Dam diverts water to the Jeffrey Supply Canal although downstream irrigation deliveries are by-passed. Sewage and industrial wastes discharged to the North and South Platte Rivers by North Platte follow the flow pattern. The Supply Canal continues to Jeffrey Regulating Reservoir, which handles fluctuations affecting power output of the hydroelectric plant located below. Returned water is used for downstream irrigation requirements. Flow in excess of irrigation needs, is diverted to Johnson Supply Canal; additional contributions are made to this canal by 12 canyon reservoirs.

Johnson Regulating Reservoir is used largely in connection with power production; other uses include recreation and fish and wildlife. Discharge from downstream regulating reservoirs passes through two hydroelectric power plants designated as Johnson No. 1 and No. 2 which utilize water at selected locations in the discharge systems. The discharge from the Johnson No. 2 hydroelectric power plant must be released to the river to satisfy the water rights of Elm Creek and Kearney Canals downstream.

Water is diverted at Brady Diversion Dam to serve power and irrigation purposes; it serves 30 Mile Canal which wastes to the river by Orchard and Alfalfa Canal and Gothenburg Canal. The Gothenburg Power Plant, located on the north bank, wastes to the Platte River. Cozad Ditch receives Platte River water diverted near Gothenburg and wastes to Dawson County Canal. Water from this canal used for irrigating crops contains sewage and, to a limited extent, industrial wastes.

The diversion structure for Dawson County Canal system is located on the Willow Island Channel of the Platte River near Cozad. Elm Creek Ditch, formerly known as Farmers' Union Canal, diverts in the vicinity of Overton. The diversion structure is temporary and subject to damage.

Kearney Canal with the oldest water rights in the Basin has priority to water and irrigation for power. Power appropriations were increased in 1920. The diversion dam for this system is located on the Platte River southwest of Elm Creek. Further contribution to the canal is made by diverting water from Buffalo Creek. Waste waters into which sewage and industrial wastes are discharged are returned to the Platte River.

Six Mile Ditch diverts from the south bank of the Platte River below Brady Control Dam. Sewage from Gothenburg is included in the water diverted for irrigation purposes.

Orchard and Alfalfa Canal receives water at a diversion south of Willow Island and returns to the Platte River west of Lexington. Sewage and industrial wastes are included in the flow of the river in this reach of the main stem.

Potential Projects

A review of potential developments, as included in the comprehensive plan of the Bureau of Reclamation, is presented to indicate the intricacy of the program and the over-all contemplated water use in the Basin. The plan is not final and is subject to change contingent upon future developments by the Bureau of Reclamation.

Under the comprehensive plan of the Bureau of Reclamation, Lake McConaughy would be the major source of water supply for the entire area above Kearney and would provide long term holdover of water for the integrated storage systems which include eight major potential reservoirs (table P-3). The plan uses existing Sutherland and Maloney Regulating Reservoirs with added improvements.

The Sutherland Outlet Canal capacity is to be increased to enable higher flows to reach Maloney Regulating Reservoir. Potential South Bluff Canal and Maloney Pumping Plant would supply water to irrigable land already serviced to a minor degree.

Water diverted at Maxwell is directed through Jeffrey Supply Canal to the Regulating Reservoir for irrigation use. Below Jeffrey Regulating Reservoir, potential Conroy Canal would serve the area east of the regulating reservoir.

Bison Reservoir is planned for Buffalo Creek to control waters originating in the East and West Forks of this stream. It would serve as a multiple purpose reservoir which includes irrigation, hydroelectric power, flood control, recreation, and fish and wildlife. Part of the reservoir discharge, together with the flow of Gothenburg Highline Canal, would serve potential French Creek Canal. The remainder would pass through Bison Hydroelectric Plant to potential Darr Feeder Canal and thence to existing Dawson County Canal.

Improvements involving the installation of Gothenburg Highline Canal, including potential Gothenburg Pump Canals, would replace the existing Gothenburg Canal and provide service to additional land. The potential canal would extend from Brady Diversion Dam to Bison Reservoir.

Plum Creek Reservoir would supplement storage of the Sutherland system and would alleviate overtaxing the capacity of Johnson Supply Canal thus permitting the use of that canal for the irrigation of additional acreage as well as to meet the demands placed on the canal by lands irrigated by E-65 and Phelps County Canals. To avoid delivery difficulties due to lengthy canals, it is proposed to construct Bertrand Reservoir near the town of Bertrand and east of Plum Creek Reservoir. Bertrand Reservoir would receive its water from the E-65 lateral and would assist in irrigating lands under that portion of the lateral system southeast of the reservoir site.

An extension of existing 30 Mile Canal to Plum Creek, and use of an existing wasteway to supply Orchard and Alfalfa Canal in lieu of the original point of delivery by the Platte River, would result in a reduction of water loss and a possible decrease in diluting water volume in the Platte River.

Improvements to the E-65 lateral system will increase the existing capacity. E-65 lateral will discharge into Bertrand Regulation Reservoir. In order to attain a greater use of water it is planned to replace Johnson Hydroelectric Plant (No. 2) with Plum Creek Reservoir Hydroelectric Plant to be located below the dam. Waste water would be directed by potential Lexington Diversion Dam to the proposed Amherst

Reservoir on Wood River by way of Amherst Feeder Canal. Dismal and South Loup Rivers would be diverted above Cumro, Nebraska, and would be carried along the south side of the valley and through the South Loup-Wood River Divide by means of potential South Loup Feeder Canal, becoming tributary to the potential Amherst Reservoir north of Watertown.

Releases of water from potential Amherst Reservoir would be made directly to potential Riverdale Canal extending along the south side of Wood River to Kearney. A portion of the water would be pumped by the Glenwood Pumping plant to a canal feeding the highland area south of Riverdale. A hydroelectric power development at Riverdale would utilize the waters not required for irrigating lands serviced by the Riverdale Canal. Water passing through this power installation would be dropped into Wood River to be diverted by the proposed Wood River Diversion Dam into Wood River and Buda Canals, the former to irrigate lands north of Wood River and the latter to service those lands between Wood River and Platte River. Buda Canal would feed Adams County Canal at the Platte River siphon.

Potential Glenwood Pumping Plant and Canal would begin on a turnout of the Riverdale Canal and would include a lift pump designed to raise water through a force main into a potential distribution canal. The proposed irrigation system includes District Pumping Units located near the canals and laterals to supply water from the underground reservoir during dry periods.

Potential Cairo Regulating Reservoir to be located on Dry Creek west of Cairo would receive most of its water from the Middle Loup River at Rockville. Part of the water discharged from the reservoir would flow southeastward through potential Grand Island Canal to cross the South Loup River in a siphon near St. Michael. The canal would receive additional water from the South Loup River and Mud Creek at this point from Ravenna Diversion Dam and Feeder Canal, and would flow to Cairo Regulating Reservoir. Excess waters from Cairo Reservoir would be directed to potential Osceola Canal.

Potential Bellwood Reservoir would regulate the water carried by potential Osceola Canal in addition to impounded waters of Clear Creek. Flows from Bellwood Reservoir would be supplemented by water diverted at St. Paul Diversion Dam below the confluence of the North and Middle Loup Rivers. This additional water would follow Central City Canal into the Platte River Valley from a crossing on Silver Creek. Chapman Canal would extend farther south and waste to the Platte River west of Central City, while Central City Canal would extend eastward along Silver Creek to terminate at the siphon on the Platte River, south of Clarks. This water would supply Bellwood Canal which would extend from a point near Clarks to Linwood. Potential Linwood Canal would receive Platte River water by proposed Columbus Diversion Dam.

Diversions made at potential Columbus Diversion Dam will feed Linwood Canal which will receive waste waters from Bellwood and Schuyler Canals which would supply the lands in the vicinity of potential Shell Creek Reservoir with irrigation water as well as lands on the north side of Maple Creek and in the Plattehorn Division. Schuyler Canal would discharge through Maple Creek Power Plant and follow the Platte-Maple Creek Divide to Nickerson Power Plant and terminate in the vicinity of the town of Nickerson.

The potential Shell Creek Reservoir would receive water from Shell Creek and from the Loup River by potential Platte County Canal and would have irrigation and flood control uses.

PRESENTATION OF DATA

Public Water Supplies

All public water supplies in the main Platte River Basin are from ground water sources and service 172,900 people with about 28.24 million gallons daily (table P-5). Treatment problems are limited to the reduction of iron, manganese and hardness. Chlorination is used in some instances to insure the constant output of a biologically safe water.

Five of the 57 municipalities listed in table P-5 treat their water supplies. Lincoln aerates its water principally to remove manganese; the water is filtered and chlorinated at the plant located near wells in the vicinity of Ashland. Grand Island chlorinates its water supply. At North Bend the supply is aerated and filtered; similar treatment is accorded the Prague water supply. Plattsmouth chlorinates its water in addition to preliminary aeration and filtration.

Pollution Contributed to Water Resources

Table P-6 summarizes the location and magnitude of significant sources of organic pollution, including industrial wastes discharged to streams of the main Platte River Basin. The total population equivalent connected to sewers is 336,250, of which 166,590 is the domestic sewage contributed and 169,660 represents the pollution load attributed to industrial wastes.

The population equivalent discharged after treatment is 234,125, a reduction of 102,130, or 30 percent. Eleven of the 22 municipalities sewered have treatment facilities; three communities are serviced by septic tanks which are not accredited with any pollution reduction. Three cities utilize primary treatment for a total sewered population equivalent of 3,630 and reduce it to a discharged pollution load of 2,725, an efficiency of 25 percent. Five cities reduce a sewered load of 171,200 population equivalents to 69,975 with secondary treatment, Table P-5. Platte River and Minor Tributaries - Municipal water supplies from ground sources

Municipality[1]	Source[2]	Treatment[3]	Population Served	Average Consumption M.G.D.
Abie	W	N	100	0.007
Ashland	W	N	1,500	0.160
Bellwood	W	N	400	0.025
Brady	W	-	450	0.027
Brainard	W	N	400	0.025
Bruno	W	N	150	0.010
Cairo	W	N	400	0.050
Cedar Bluffs	W	N	475	0.050
Central City	W	N	2,700	0.230
Ceresco	W	N	325	0.020
Clarks	W	N	400	0.025
Cozad	W	N	1,950	0.200
Doniphan	W	N	360	0.030
Duncan	W	N	200	0.015
Dwight	W	N	275	0.015
Elm Creek	W	N	600	0.030
Elwood	W	N	500	0.050
Eustis	W	N	400	0.030
Farnam	W	N	300	0.035
Firth	W	N	200	0.020
Fremont	W	N	10,700	2.057
Funk	W	N	100	0.010
Gibbon	W	N	650	0.100
Gothenburg	W	N	1,950	0.200
Grand Island	W	D	20,000	4.090
Greenwood	W	N	300	0.050
Hershey	W	N	350	0.030
Hickman	W	N	300	0,020
Kearney	W	N	9,500	1.730
Lexington	W	N	3,000	1.000
Lincoln	W	ADF	85,000	13.500
Lindsay	W	N	250	0.015
Louisville	W	N	900	0.080
Malmo	W	N	150	0.005
Mead	W	N	250	0.010
Miller	W	N	180	0.004
Morse Bluff	W	N	150	0.015
Newman Grove	W	N	1,000	0.100
North Bend	W	AF	925	0.140
North Platte	W	N	11,000	2.000
Oconto	W	N	150	0.015
Overton	W	N	450	0.040
Paxton	W	N	460	0.020
Platte Center	W	N	400	0.040
Plattsmouth	W	ADF	3,500	1.000
Prague	W	AF	350	0.010
Rogers	W	N	100	0.005
Schuyler	W	N	2,000	0.300
Shelton	W	N	1,000	0.060
Silver Creek	W	N	300	0.010
Springfield	W	N	350	0.025
Sutherland	W	N	600	0.050
Valparaiso	W	N	380	0.040
Wahoo	W	N	2,500	0.275
Waverly	W	N	275	0.030
Weston	W	N	350	0.008
Wood River	W	N	980	0.100
Total			172,885	28.238

[1] All municipalities listed are located in the State of Nebraska

[2] Source - W - Wells

[3] Treatment - N - None
A - Aeration
F - Coagulated, settled, filtered
D - Chlorinated
H - Softened

Table P-6. Platte River and Minor Tributaries - Sources of pollution including industrial wastes expressed as sewered population equivalent (B.O.D.)

Municipality[1]	Miles above Mouth Platte River	 Tributary	Industrial Wastes as Population Equivalent (B.O.D.)	Population Connected to Sewers	Treatment[2]	Sewered Population Equivalent (B.O.D.) Untreated	 Discharged
Platte River							
Louisville	17.2		-	300	N	300	300
Salt Creek	26.4						
Wahoo Creek		2.8					
Wahoo		25.0	2,165	3,300	N	5,465	5,465
Weston		33.2	-	100	N	100	100
Ashland		3.8	-	1,000	N	1,000	1,000
Lincoln		25.0	47,500	85,000	S	132,500	53,000
North Bend	72.8		-	1,100	S	1,100	350
Shell Creek	83.5						
Lindsay		62.8	-	100	P	100	75
Newman Grove		69.7	1,725	850	ST	2,575	2,575
Lost Creek	84.0						
Schuyler		4.0	-	2,500	N	2,500	2,500
Columbus[3]	103.0		4,270	7,070	N	11,340	11,340
Silver Creek	127.2		-	300	N	300	300
Central City	148.4		1,240	1,890	P	3,130	2,350
Wood River	161.4						
Grand Island		13.0	12,300[4]	24,000	S	36,300[4]	16,300[4]
Wood River		32.6	-	600	S	600	150
Shelton		43.1	-	700	S	700	175
Gibbon		54.4	-	500	ST	500	500
Turkey Creek	210.1						
Kearney		1.5	4,640	10,480	N	15,120	15,120
Elm Creek	231.4						
Elm Creek		2.2	-	400	P	400	300
Lexington	252.5		1,825	3,000	ST	4,825	4,825
Cozad	265.1		75	3,600	N	3,675	3,675
Gothenburg	272.0		-	2,800	N	2,800	2,800
North Platte River	309.8						
North Platte		5.0	28,225	17,000[5]	N	45,225	45,225
Total			103,965	166,590		270,555	168,425

[1] All municipalities are within the State of Nebraska.

[2] Treatment - N - None
P - Primary
S - Secondary
ST - Septic tank

[3] Columbus in the Loup River Basin is a Platte River problem.

[4] 65,700 population equivalents, due to fall operation of the beet-sugar refinery at Grand Island, are discharged untreated to Wood River. This plant was not in operation during the survey period.

[5] Approximately one-third of the domestic wastes are discharged untreated to South Platte River.

an average reduction efficiency of 59 percent. It is interesting to note that beet sugar wastes account for 65,700 population equivalents at Grand Island; this industry operates at the culmination of the beet growing season in the fall and was not in production during the survey. Effective treatment of beet sugar wastes would reduce materially the pollutional load on Wood River. Thirty-six percent, or 8 of the 22 cities listed, have primary and secondary treatment plants. This is below the national average of approximately 60 percent.

Low-Flow Frequencies

A brief study was made of the frequency of low flows over the period of record. Tables P-7 and P-8 present the frequencies of low mean monthly summer and winter flows for recorded years, respectively. These were obtained by selecting the lowest mean monthly flow for the summer period, June-September inclusive, and the lowest mean monthly flow in the winter period, December-February inclusive. Low-flow frequencies will provide an indication of the degree and recurrence of possible nuisances below sources of pollution and provide a firm basis for treatment requirements.

Low summer flows bear consideration as critical oxygen conditions may arise in periods of high temperature. Winter flows are usually of lesser import because of reduced biological activity and the fact that oxygen is more soluble in water at low temperatures and can therefore attain a higher degree of saturation. Whenever streams become ice covered problems of reaeration may arise. A winter investigation of the lower reach of the Platte River showed that ice cover was not complete and that open areas would probably permit sufficient reaeration to satisfy stream demands.

The porous sandy beds of the Platte River are unstable and during periods of low flow the water recedes to the channels formed by the more powerful currents existing at high stages. It is extremely difficult to ascertain where the main channel may be which creates a problem in the development of outfall sewer construction, so that sewage will reach the flows afforded for dilution. Numerous other factors complicate provisions for adequate dilution flows at sources of pollution.

Low Flow Variation

A review of tables P-7 and P-8 will show that stream discharge in the Platte River varies considerably from one staging location to another regardless of their relative positions upstream from the mouth. Typical of the condition is the minimum monthly summer flow expected once in ten years at Brady at 8 c.f.s., while 40 miles downstream at Lexington it is 140 c.f.s., and 8 miles lower at Overton zero flow may be expected. These variations are chiefly the result of power use and the development of irrigation systems having their origin late in the nineteenth century. State law which holds that a prior dated water

Table P-7. Platte River and Minor Tributaries - Frequency of low mean monthly summer (June - Sept.) discharges[1]

Years of Record	Stream and Location[3]	Miles to Mouth		Drainage Area Square Miles	Minimum Monthly Mean Flows in cubic feet per second that may be expected once in:				
		Platte River	Tributary		2 years	3 years	5 years	10 years	Minimum[2]
	Platte River								
11	Ashland	28.5			1,500	1,200	900	780	660
14	Duncan	115.0		4,652	1	0	0	0	0
14*	Grand Island	173.2			0	0	0	0	0
16*	Kearney	215.6			7	0	0	0	0
16*	Odessa	224.8			0	0	0	0	0
16	Near Overton	240.4		1,699	30	0	0	0	0
13	Lexington	252.5		1,625	1,000	270	240	140	30
6	Cozad	265.1			73	60	38	8	8
16*	Brady	291.5			140	100	50	17	0
16	Confluence North and South Platte near North Platte	309.8			370	180	120	72	59
	Wood River	161.4							
15*	Amherst		84.0		5	3	2	2	2
	Buffalo Creek	231.4							
16*	Near Bison Reservoir Site		32.6		0	0	0	0	0
	Plum Creek	245.6							
16*	Near Plum Creek Reservoir Site		4.2		0	0	0	0	0
	North Platte River	309.8							
16	North Platte		5.0		240	137	100	59	44
16	Sutherland		26.4		89	32	13	5	2
16*	Keystone		52.5		240	200	110	47	5
16*	Martin		59.5		440	340	240	100	7
5	Lewellen		84.8		660	440	380	380	380
16	Oshkosh		96.2		390	320	270	100	17
	South Platte River	309.8							
16	North Platte		4.3		55	0	0	0	0

Table P-8. Platte River and Minor Tributaries - Frequency of low mean monthly winter (Dec. - Feb.) discharges[1]

Years of Record	Stream and Location[3]	Miles to Mouth		Drainage Area Square Miles	Minimum Monthly Mean Flows in cubic feet per second that may be expected once in:				
		Platte River	Tributary		2 years	3 years	5 years	10 years	Minimum[2]
	Platte River								
11	Ashland	28.5			2,400	2,000	2,000	1,600	1,300
14	Duncan	115.0		4,652	730	42	4	2	0
14*	Grand Island	173.2			920	310	61	3	0
16*	Kearney	215.6			1,300	1,100	600	200	72
16*	Odessa	224.8			1,200	920	400	84	44
16	Near Overton	240.4		1,699	1,300	1,100	640	300	160
13	Lexington	252.5			1,800	1,700	1,600	1,400	1,400
6	Cozad	265.1			230	180	140	130	130
16*	Brady	291.5			1,000	290	170	96	86
16	Confluence North and South Platte near North Platte	309.8			1,100	770	570	450	360
	Wood River	161.4							
15*	Amherst, Nebr.		84.0		5	3	2	2	2
	Buffalo Creek	231.4							
16*	Near Bison Reservoir Site		32.6		0	0	0	0	0
	Plum Creek	245.6							
16*	Near Plum Creek Reservoir Site		4.2		0	0	0	0	0
	North Platte River	309.8							
16	North Platte		5.0		740	360	320	310	310
16	Sutherland		26.4		450	140	110	100	84
16*	Keystone		52.5		350	29	8	4	3
16*	Martin		59.5		1,400	1,300	1,200	1,100	960
5	Lewellen		84.8		1,400	1,200	1,100	960	960
16	Oshkosh		96.2		1,300	1,200	1,100	930	910
	South Platte River	309.8							
16	North Platte		4.3		180	110	74	49	0

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[1] Determined from basic data and estimates supplied by the Bureau of Reclamation

[2] Low mean month

[3] All streams and municipalities listed are located in the State of Nebraska

*From records and estimates correlated with other flow data appropriation holds a priority over an upstream or downstream user has been practiced along the Platte River and can best be exemplified by the Kearney Canal and Elm Creek systems. Water is returned to the Platte River at Lexington from irrigation and power returns where the study shows a minimum monthly summer flow expected once in two years of 1,000 c.f.c. Prior to re-entry of flow, the discharge at Brady was 140 c.f.s. The flow drops to 30 c.f.s. near Overton, and at Odessa it is zero. Diversions for irrigation account for most of this water although part of the drop may result from overdevelopment of pump irrigation in the area causing a drop in the ground water table which is recharged by gravity from the flow in the stream. Flow in Kearney Canal is for the Kearney Hydroelectric Plant. The tailrace discharges to a small stream flowing to the Platte River. The flow in the main stem may approach zero again at Grand Island. Winter flows vary to a lesser extent but losses contributed to ground water recharge and diversion to hydroelectric plants can be readily noted in the Kearney and Grand Island areas.

Other factors as stream characteristics are also related to the flow picture. The meandering nature of the Platte River, with its broad, sandy, island-studded sections, makes accurate staging extremely difficult. The stream is not confined to a permanent channel but follows several channels which may be changed in a relatively short period of time. There may be four major and several minor channels in various sections. The U. S. Geological Survey reports that the Platte River is one of the most difficult streams to gage properly.

Laboratory Results

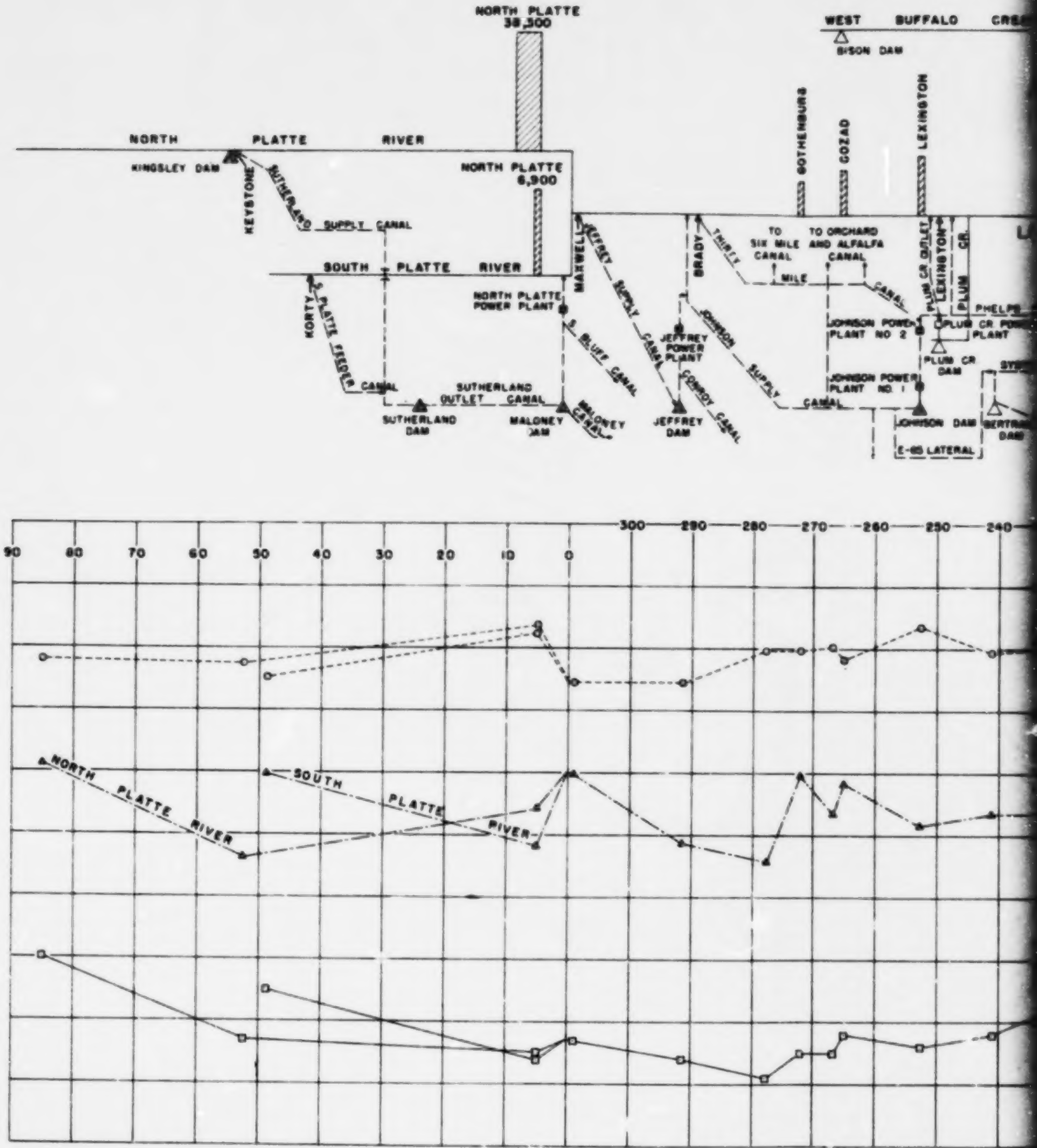
Average and median values of the laboratory results, sources of pollution and locations of proposed and existing dams, are plotted in figures P-1 and P-2; individual results are listed in appendix G. The results indicate the existence of pollution problems upon tributary streams rather than upon the main stem. Average B.O.D. values did not exceed 5.0 ppm; the critical point of 4.6 ppm. at North Bend being a culmination of numerous sources of pollution.

D. O. values did not drop below 7.4 ppm., generally varying between 7.4 and 8.2 ppm., and attaining a maximum of 9.2 ppm. The latter fact may be attributed to high flow conditions at time of sampling.

Coliform counts at Ashland and Columbus were high with median values of 23,000/100 ml. and 13,000/100 ml. respectively. Of lesser significance is the 9,300/100 ml. value at Korty on the South Platte River and at Maxwell and Gothenburg on the Platte River.

The results from tributary streams indicated pollution in significant quantity. On Salt Creek, the B.O.D. varied from 8.4 to 6.2 ppm., the D. O. dropped to 5.0 ppm., and coliforms exceeded 100,000/100 ml. Lost Creek B.O.D. averaged less than 4.0 ppm., the D.O. varied from

A



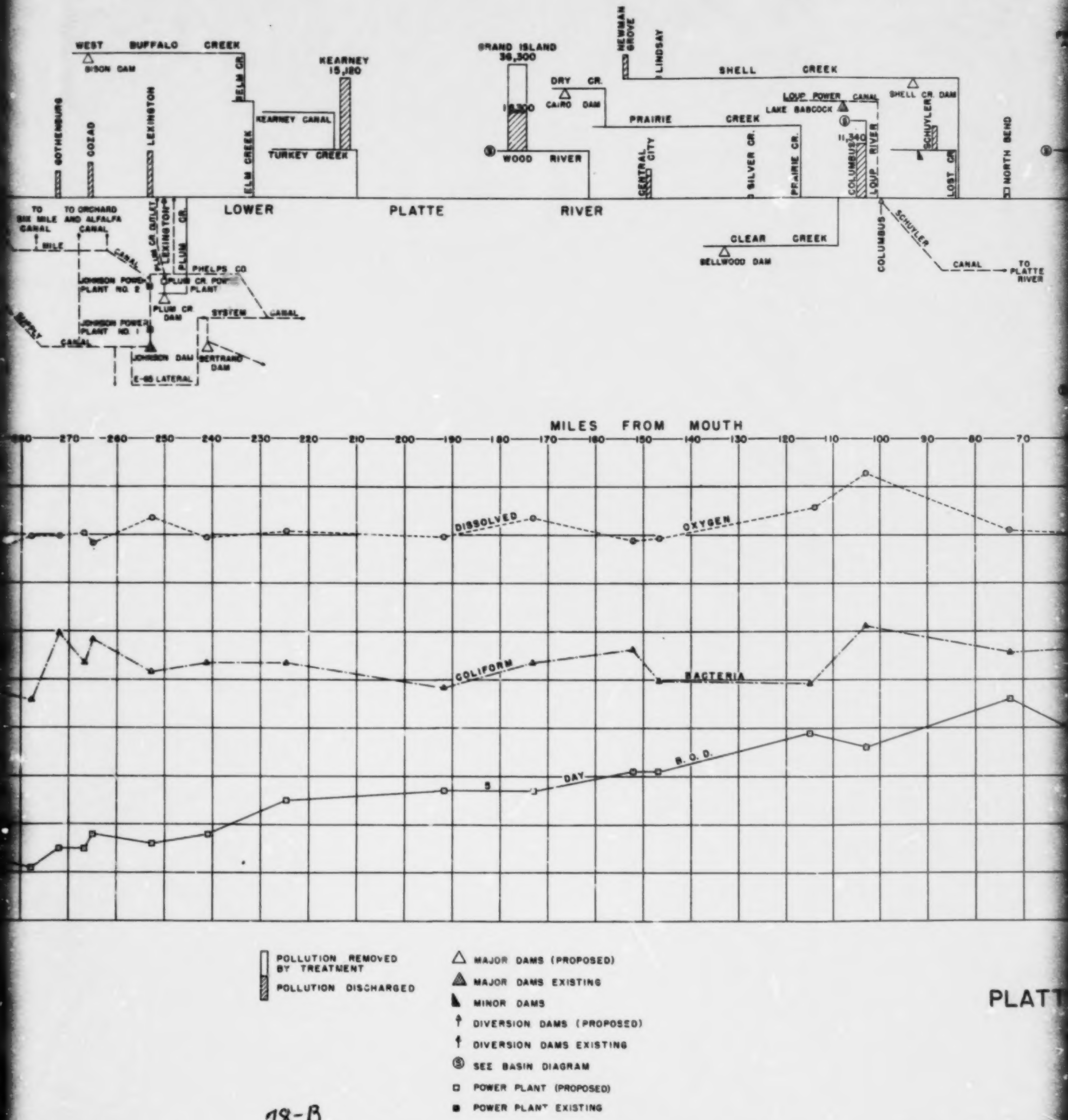
LOWER PLATTE RIVER BASIN

WATER POLLUTION INVESTIGATION

U.S. PUBLIC HEALTH SERVICE

1950

B



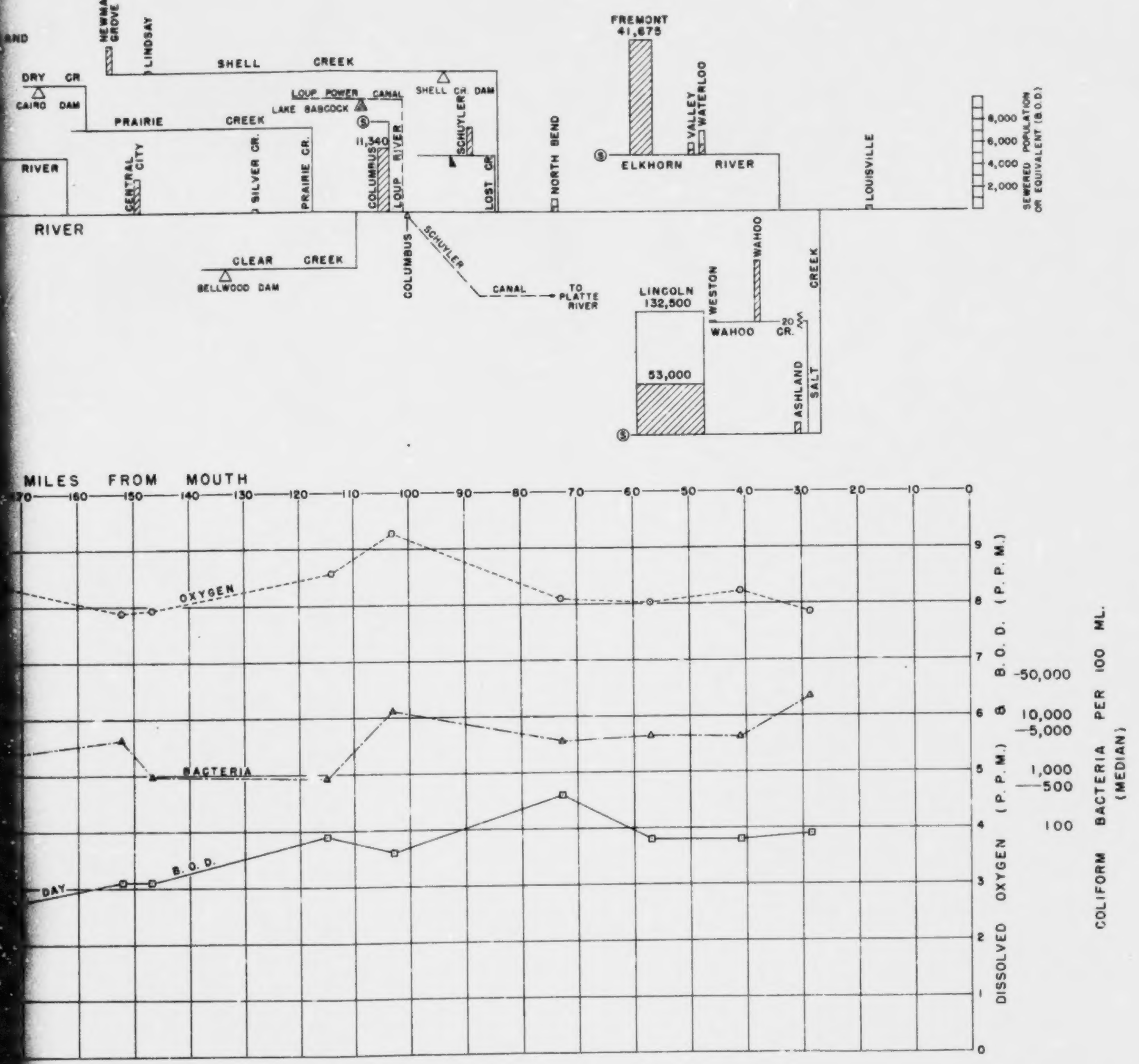
WEST BUFFALO CREEK
BISON DAM
GOTHENBURG
COZAD
LEXINGTON
ELM CR.
ELM CREEK
KEARNEY 15,180
KEARNEY CANAL
TURKEY CREEK
GRAND ISLAND 36,300
18,300
WOOD RIVER
DRY CR.
CAIRO DAM
NEWMAN GROVE
LINDSAY
SHELL CREEK
SHELL CR. DAM
PRAIRIE CREEK
CENTRAL CITY
SILVER CR.
PRAIRIE CR.
LOUP POWER CANAL
LAKE BABCOCK
11,340
COLUMBUS
LOUP RIVER
SCHUYLER
LOST CR.
NORTH BEND
LOWER PLATTE RIVER
TO SIX MILE CANAL
TO ORCHARD AND ALFALFA CANAL
MILE CANAL
PLUM CR. OUTLET
LEXINGTON
PLUM CR.
PHELPS CO.
JOHNSON POWER PLANT NO. 2
PLUM CR. POWER PLANT
PLUM CR. DAM
SYSTEM CANAL
SUPPLY CANAL
JOHNSON POWER PLANT NO. 1
JOHNSON DAM
BERTRAND DAM
E-65 LATERAL
CLEAR CREEK
BELLWOOD DAM
COLUMBUS SCHUYLER CANAL
TO PLATTE RIVER
MILES FROM MOUTH
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
DISSOLVED OXYGEN
COLIFORM BACTERIA
5 DAY B. O. D.
POLLUTION REMOVED BY TREATMENT
POLLUTION DISCHARGED
△ MAJOR DAMS (PROPOSED)
▲ MAJOR DAMS EXISTING
MINOR DAMS
† DIVERSION DAMS (PROPOSED)
† DIVERSION DAMS EXISTING
Ⓢ SEE BASIN DIAGRAM
□ POWER PLANT (PROPOSED)
■ POWER PLANT EXISTING

PLATT

78-B

FIG. P-1

C



(PROPOSED)
EXISTING

MS (PROPOSED)
MS EXISTING
AGRAM
(PROPOSED)
EXISTING

PLATTE RIVER & MINOR TRIBUTARIES

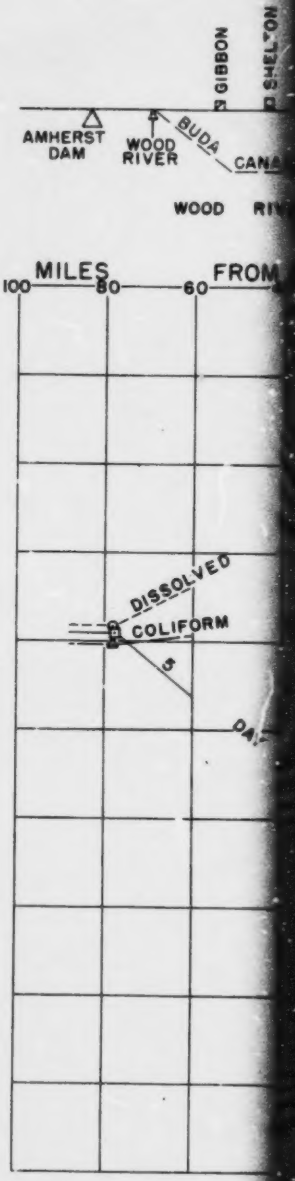
SOURCES OF POLLUTION

AND

AVERAGE LABORATORY RESULTS

APRIL, MAY, JUNE, JULY / 1949

A



LOWER PLATTE RIVER BASIN

WATER POLLUTION INVESTIGATION

U.S. PUBLIC HEALTH SERVICE

1950

▯ POLL
BY T

▨ POLL

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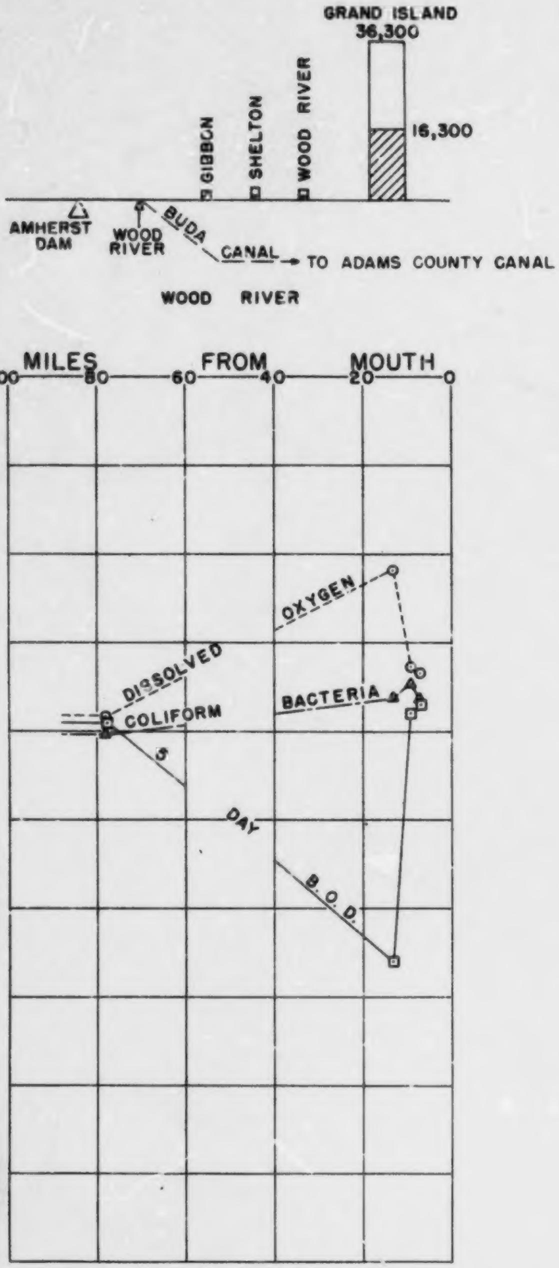

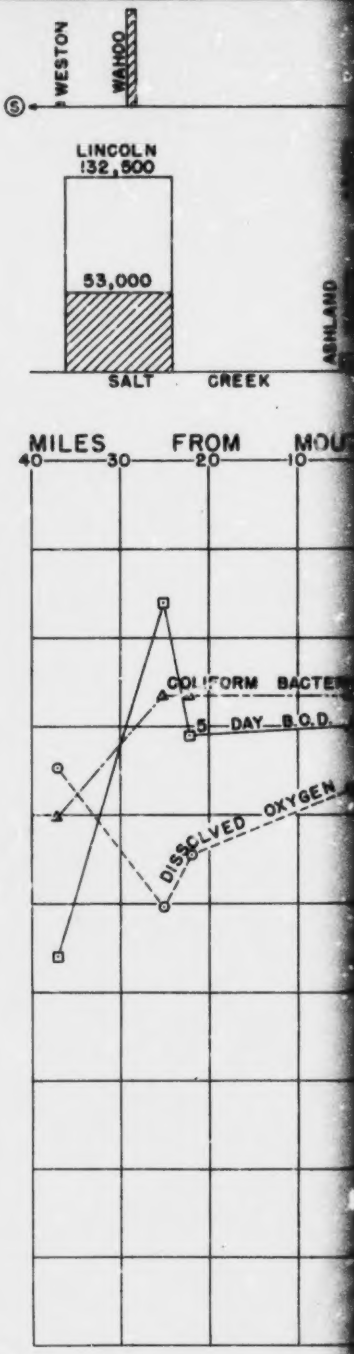

SIN

- ☐ POLLUTION REMOVED BY TREATMENT
- ▨ POLLUTION DISCHARGED

- △ MAJOR DAMS (PROPOSED)
- ▲ MAJOR DAMS EXISTING
- ◣ MINOR DAMS
- ↑ DIVERSION DAMS (PROPOSED)
- ↑ DIVERSION DAMS EXISTING
- Ⓢ SEE BASIN DIAGRAM

PLATTE RIVER B

SOURCES

AVERAGE LA

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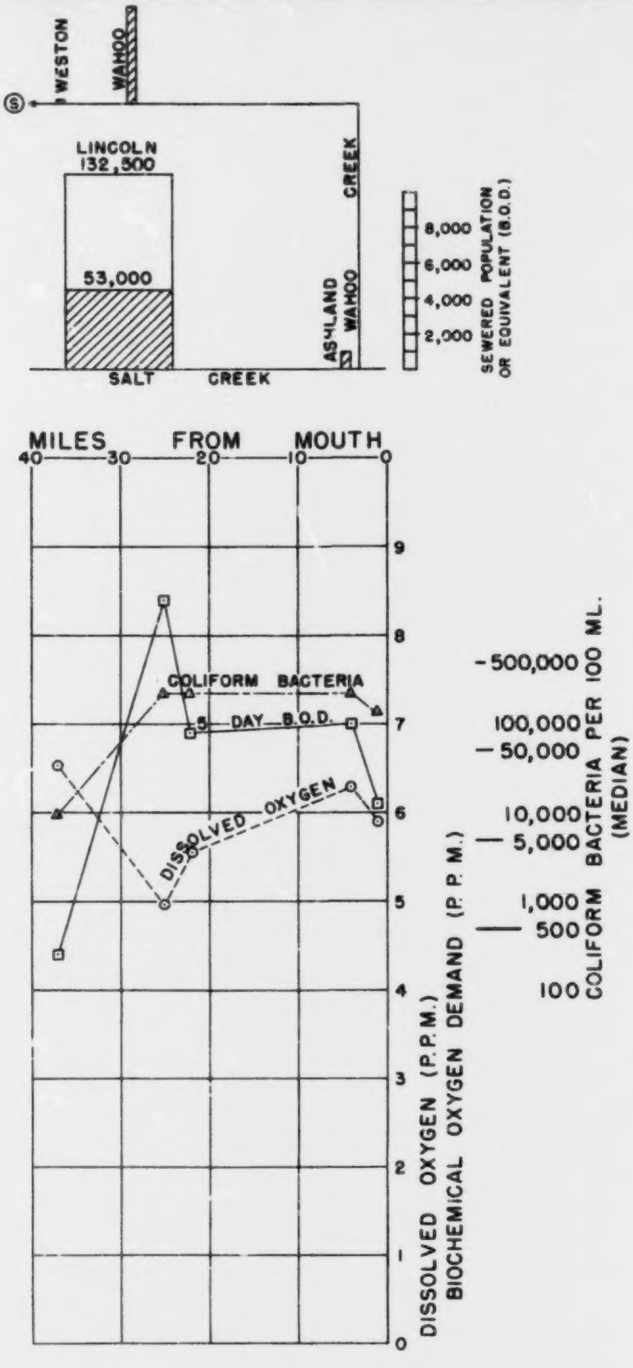
FIG. P-2

C



PLATTE RIVER & MINOR TRIBUTARIES

SOURCES OF POLLUTION

AND

AVERAGE LABORATORY RESULTS

APRIL, MAY, JUNE, JULY / 1949

SED)

G

7.5 - 8.0 ppm., but the median coliform count of 100,000/100 ml. was significant. Shell Creek had an average B.O.D. of 5.8 ppm., a D.O. of 7.7 ppm., and a coliform count of 10,000/100 ml. The B.O.D. of the Kearney Canal varied from 7.0 - 4.5 ppm., and its D.O. from 6.9 - 7.9 ppm., while the coliform count reached a value of 9,300/100 ml. Wood River had an average B.O.D. of 6.2 ppm., a D.O. of 6.3 ppm., and its coliform count was in excess of 10,000/100 ml.

Nitrate nitrogen values up to 6.0 ppm. were recorded in the examinations of waters of the Platte River and tributaries. The finding of high nitrates in the chemical examination of water provided an indication of pollution.

DISCUSSION

Stream flow from the Platte River and tributaries has been utilized for irrigation, power development and sanitation purposes. Recreation, fish and wildlife use add to the value of these streams.

Pollution in the Basin is moderate and sufficiently far apart in most instances to permit reasonable stream recovery. Pollution does not affect water supplies, but the public health significance of its presence in irrigation waters must not be neglected. Primary treatment of sewage and industrial wastes is a minimum requirement and secondary treatment is needed where flows are low. With extremely low normal flows additional treatment should be undertaken. The value of water to the economy of the area makes it desirable to conserve this resource by a high degree of sewage treatment.

Municipal Water Supplies

Public water supplies are taken from ground sources in the Platte River area. The quality of the ground water has been found to be good and treatment, resorted to in a few cases, is limited to chlorination, removal of iron and manganese, and reduction of hardness. High nitrates have been reported in 4 percent of municipal water supplies tested in Nebraska[1] by the State Department of Health and is significant as related to methemoglobinemia. Ample ground water exists within the Basin for municipal water supplies and there is no indication that consideration will be made in the immediate future for utilizing surface streams for potable water use. However, studies by the Geological Survey indicate the water table had been lowered in some places east of Kearney during the drought period of the 1930s probably because of heavy withdrawals for irrigation and the lack of artificial recharge by gravity irrigation. In the Grand Island area where the water table was 30 or 40 feet below the land surface, depression to 60 or 70 feet during the above drought period was caused probably by heavy municipal and industrial use. It is interesting to note in a paper "Ground Water in Nebraska", by Geology Professor A. L. Lugn[1] of the University of Nebraska, both Lincoln and Grand Island are situated in areas less abundantly endowed in ground water resources than other areas in Nebraska. In the Grand Island area the rate of pumpage increased from 1,600 acre-feet in 1920 to 8,750 acre-feet in 1946. These figures varied with the drought occurring in that period. The heavy use of ground water was accompanied by a corresponding reduction of aquifer strata thickness.

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[1] "Nitrates and Nitrites in Nebraska Water Supplies." Jeanette M. Debus, Second Annual Water Works Conference 1949.

The growth of industry related to agriculture has been a factor in the lowering of the ground water table in the Grand Island and Kearney areas. A continued expansion in industry may parallel the expected increase in population. An increased demand upon the water supply would then result due to quantities of water required for processing, cooling, and wash waters. In addition it is well to note the growing use of water in the field of air conditioning for commercial and private purposes.

The same problem noted above for Grand Island will confront other communities and private users of the ground water reservoir if more extensive well irrigation takes place without recharge due to gravity or canal irrigation. This trend has already been noted between Gibbon and Grand Island and indicates a rate of withdrawal greater than the rate of replenishment. Consumer towns below Columbus feel that upstream developments may cause a ground water reservoir depletion. This is true particularly in the case of Lincoln with several wells located along the Platte River near Ashland, developed to combat an existent water problem in 1931.

The discovery by an Iowa physician of a relationship between water supply and the contained nitrate nitrogen and methemoglobinemia has made nitrate nitrogen in water supplies a factor of increasing public health importance. This is very important when considering private supplies as 20 percent of such wells tested by the Nebraska Department of Health showed objectionable amounts of nitrate. Even waters containing seemingly low values may attain concentrations of 10 ppm. or more when boiled and may prove nocuous to babies less than 6 months of age. Nitrates in water supplies are discussed in detail in appendix E.

Irrigation Water Quality

The public health significance of bacteriological pollution in irrigation waters must not be neglected. The type of crops irrigated is important from a public health viewpoint, particularly with the extensive irrigation plans. Bacteriological standards have not yet been determined but studies now under way will provide much needed additional information. A general discussion of this subject has been presented in the introduction and in appendix D.

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[1] Lugn, A. L., "Ground Water in Nebraska," "Unpublished Report." Similar article "Ground Water Worth Millions" published in Nebraska Farmer (Feb. 22, Mar. 8, Mar. 22, 1941).

Polluted waters will be diverted at most diversions and may be significant below major sources of pollution. This will occur below North Platte, Lexington, and Columbus.

Sources of Pollution and the Status of Sewage Treatment

As shown in table P-6, 11 communities discharge raw sewage to streams of the Basin. In addition, 3 towns have septic tanks which, for practical considerations, must be included in that group not providing treatment. Among the larger of these communities are North Platte, Kearney, Columbus, Wahoo, Lexington, Cozad, Gothenburg, Schuyler, and Newman Grove.

North Platte discharges to both the North and South Platte Rivers in a ratio of 2 to 1 respectively insofar as domestic wastes are concerned. The majority of industrial wastes reach the North Platte River. Both domestic and industrial wastes are included with the flow diverted at the Maxwell diversion structure for irrigation use. Wastes reaching the Jeffrey Regulating Reservoir may be reduced in this impounded area but may cause algae and other undesirable conditions. Pollution flowing over the Maxwell Diversion Dam continues downstream and serves to supplement the untreated sewage contributions of Gothenburg, Cozad and Lexington.

Kearney discharges raw wastes to a small tributary. As the point of discharge is 1.7 miles above its confluence with the Platte River, the pollution problem is extended into the latter stream. Columbus, located on the Loup River less than a mile above the confluence with the Platte River, discharges pollution so that it becomes a Platte River problem in a very short time. At one time Columbus operated a primary treatment plant which is now in a state of disrepair.

Newman Grove on Shell Creek utilizes a septic tank plant. The addition of industrial wastes to this plant, the efficiency of which is practically zero, has a desultory effect upon conditions in Shell Creek.

Wahoo discharges raw sewage to Wahoo Creek and Schuyler disposes of its untreated wastes to Lost Creek.

Three cities provide primary treatment: Lindsay, Central City, and Elm Creek. Central City is replacing a primary plant with a higher degree of treatment. Treatment at Lindsay and Elm Creek appear adequate.

The remaining five communities have secondary treatment plants. Lincoln, at Salt Creek, has a trickling filter plant in operation. However, secondary sedimentation features are lacking and this, coupled with the fact extension of sewage disposal improvements has not kept pace with the growth of the metropolitan area, has resulted in overloading Salt Creek with the creation of a serious pollution condition.

Grand Island on Wood River, in carrying out a $350,000 improvement program, has expanded its activated sludge type sewage plant by the recent installation of an improved and larger grit chamber, primary clarifier, additional aeration tank capacity, and a final sedimentation tank. During the sugar-beet season which continues for approximately three months, additional wastes estimated as 65,700 sewered population equivalents are contributed to that stream without benefit of any treatment. Wastes from the beet-sugar factory are discharged to a channel leading to Wood River. The problem is alleviated to some extent because the Steffens' wastes are discharged to lagoons formed by lime culm piles.

The wastes from North Bend, Shelton, and Wood River are adequately treated by secondary processes.

The City of Alliance, located in the Sand Hills area, utilizes the natural topographical aspects of the region for waste disposal. Its wastes are discharged to lakes without prior effective treatment. The primary lake serving as a lagoon has an area of about 45 acres and discharges to a smaller lake about 10 acres in area. Inspection revealed the absence of nuisances. Although in an isolated location, the area should be fenced completely and trespassing prohibited.

Stream Conditions and Sewage Treatment Needs

The degree of sewage treatment required is based upon normal low flow expectancies and downstream water use. Critical conditions may be anticipated where stream discharges provide insufficient dilution to preclude the possibility of nuisances. The present evaluation is founded upon conditions observed during the pollution investigations coupled with analyses of historical and estimated discharge records. It does not reflect possible increase in minimum flow resulting from the development program. The benefits of increased minimum discharges which may permit a lesser degree of sewage treatment will be discussed in a later section.

A minimum of primary treatment should be provided to avoid local pollution problems. When the unregulated stream flow is intermittent or the dilution provided is inadequate to handle the pollution load after primary treatment, a minimum of efficient secondary treatment is indicated. Downstream recreational use or utilization of polluted streams for irrigating crops consumed raw may necessitate additional treatment in the form of disinfection by chlorination for the control of pathogenic organisms.

The following communities, all of which discharge raw sewage to streams of the Basin, require a minimum of primary treatment: Gothenburg, Lexington, Gibbon, Columbus, Weston, and Louisville.

The wastes of the following communities now untreated may need secondary treatment: North Platte, Cozad, Kearney, Silver Creek, Schuyler, Newman Grove, and Wahoo. At present the City of North Platte discharges wastes to the North and South Platte Rivers. Treatment at North Platte has been considered using one or two plants because of the location of existing outfall sewers. Treatment required in both instances may be secondary.

Lincoln, with secondary treatment facilities, discharges 53,000 sewered population equivalents to Salt Creek. During the survey period a broken 10-inch diameter sewer was discharging directly to Salt Creek and increased the sewered population equivalents by a substantial amount. Lincoln, the State Capitol, is continuing in development as a manufacturing center. Extension of the present sewerage system and expansion of the existing sewage treatment plant is essential for the correction of nuisance conditions in Salt Creek. Secondary sedimentation tanks should be added to the existing trickling filter plant. Industrial wastes discharged to streams should be treated at the municipal plant or should receive similar treatment by individual installations.

Grand Island is enlarging the present activated sludge sewage disposal plant, which will do much to improve the degree of treatment provided by this secondary process. The condition of Wood River, which receives the treated sewage, is probably aggravated by untreated wastes from a beet-sugar refinery at Grand Island that operates during the fall season. Steps should be taken to have this industrial waste treated to the same degree as sewage from the municipality. As it is reported that Wood River flow at Grand Island may approach zero, a high degree of treatment with competent and effective operation is a prerequisite to the prevention of nuisance conditions.

Central City is replacing its Imhoff tank primary plant with a secondary treatment unit. Stream analysis indicates the desirability for such treatment.

Flow Needs: Benefits and Damages

The development program may provide increased minimum flows sufficient to permit a lower degree of sewage treatment which would produce tangible monetary benefits attributable to the reservoir regulating this flow. Contrariwise, damages may result if flows are reduced beyond the required minimum by water diversion to other use. In this connection, it may not be assumed that pollution damage will not be suffered if regulation provides the minimum flow at a value about equal to the unregulated minimum previously prevailing. Actually, stream conditions would be as bad as during the unregulated minimum and worse during the additional time when the regulated flow is equal to the normally unregulated minimum.

Specified flows are presented in table P-9. Useful desirable minimum flows are based upon a minimum of efficient primary treatment (35 percent B.O.D. removal) except where a higher degree of treatment is already provided, summer season temperatures, and a minimum of 5 ppm. dissolved oxygen in the stream. Secondary treatment desirable flows assume efficient secondary treatment (a minimum of 75 percent B.O.D. removal), summer season temperatures, and a minimum of 5 ppm. dissolved oxygen in the stream. These flows have been estimated to provide a basis for comparing additional treatment against the value of the water made available for irrigation or other use.

Flow necessary to prevent damage is taken usually from normal minimum stream flows unless the useful desirable flow is lower, when the latter is specified. In those cases where no flow may be encountered, the necessary flows have been based on a rather high degree of treatment--88 percent removal of B.O.D.--which will require an exceptionally effective secondary treatment or tertiary treatment. The specified degree of treatment was taken as a reasonably high goal that may be achieved and to provide an estimate of the magnitude of minimum flows needed with that treatment.

Flow needs during other seasons of the year will vary with water temperature and are presented as percentages of the summer period flows in table 10, General Section.

Flows presented for Grand Island are those for the summer period and do not include wastes from fall seasonal operations of the beet-sugar refinery. The following flows indicate the fall month needs based on (1) primary treatment of the industrial waste with present sewage treatment and (2) effective secondary treatment of all wastes:

	(1)	(2)
October	135 c.f.s.	57 c.f.s.
November	110 "	45 "
December-January	60 "	25 "

Provisions for flows in Column 1 would result in additional cost benefits.

Tangible annual monetary benefits as a result of pollution control by a lower degree of sewage treatment resulting from flow regulation are presented in table P-9. Similarly, damages are shown based upon a decrease in desirable flows.

It is not possible in a comprehensive report of this type to adequately cover all the detailed phases of the numerous pollution

Table F-9. Platte River and Minor Tributaries - Flow needs and cost evaluation

Municipality	Stream	Approximate Miles from Mouth Platte River	Approximate Miles from Mouth Tributary	Minimum Normal Flow c.f.s.	Useful Desirable Minimum Flow* c.f.s.	Secondary Treatment Desirable Minimum Flow c.f.s.	Necessary to Prevent Damage to Municipality	Annual Tangible Monetary Benefits Possible if Flow in Column 6 is Provided	Preliminary Estimate Minimum Mean Monthly Flow Under Proposed Flow Regulation Program	Annual Tangible Benefits (/) and Damages (-) Under Proposed Flow Regulation Program (Estimated Flow in Column 10)
1	2	3	4	5	6	7	8	9	10	11
North Platte	North Platte R.	310.0	5	59	120	25	59	$ 45,200)	170)	$ /45,200
	South Platte R.	310.0	4	-	25	10	10	)	)	
Gothenburg	Platte River	272.0		6¹	8	4	8		0	- 3,100
Cozad	Platte River	265.1		5	19	8	8	4,000	0	- 4,000
Lexington	Platte River	252.5		140	16	6	16	0	0	- 5,000
Elm Creek	Elm Creek	231.4	2.2	-	2	1	2	0	-	-
Kearney	Platte River	210.1		0¹	48	19	-	15,600	-	-
Gibbon	Wood River	161.4	54.4	2¹	2	1	2	0	0	- 800
Shelton	Wood River		43.1	5¹	3⁴	3	3	0	0	-
Wood River	Wood River		32.6	4¹	3⁴	3	3	0	0	-
Grand Island	Wood River		13.1	-	53⁴	53	-	0	0	-
Central City	Platte River	148.4		0	12⁵	12	-	0	-	-
Columbus	Platte River	103.0		102²	50	22	50	0	77	0
North Bend	Platte River	72.8		-	3⁴	3	-	0	37	0
Ashland	Platte River	26.0		780	235³	-	235³	0	-	-

*Based on primary treatment.

[1] Estimate.

[2] Loup River at Columbus.

[3] Based on recommended treatment at Fremont, Lincoln, and Wahoo.

[4] Secondary treatment plant in operation.

[5] Secondary treatment plant under construction.

problems. In certain cases, more comprehensive study may be indicated. Large increases in populations at metropolitan centers, new industry or expansion of existing industry will necessitate revision. Where normal flows approach zero sustained minimum flows compatible with secondary treatment provided by a regulation program may in specific cases be appraised as an annual monetary benefit.

The development program may realize sizable tangible annual monetary benefits where desirable minimum flow needs are met. North Platte and Kearney are in this category. The City of North Platte may benefit to the extent of $45,200 per year as a result of increased minimum normal flows. Utilization of potential Buda Canal as the receiving stream for Kearney's wastes would materialize in a benefit of $15,600, provided sufficient minimum flows are present. Possible damages from decreased flows resulting from the development program are presented in table P-9. Consideration might be given to rerouting certain discharges to achieve these benefits without loss of water for irrigation and other uses.

The Effect of Reservoirs on Pollution Assimilation Capacity of Streams

Reservoirs reduce the pollution present in the effluent streams as they provide large volumes for dilution, increased time of passage thereby permitting additional biological action, and decreased velocities allowing deposition and retention of settleable and suspended waste particles. Reservoirs can absorb the load up to the point at which they maintain a favorable oxygen balance. The preservation of favorable oxygen conditions in impoundments is abetted by pretreatment of wastes before the pollutants leave the outfall sewers to reduce quantity of solid matter, by the aerating effect of wind action, and by the development of algae which add to the oxygen content of the water. However, excessive algae growth may cause downstream pollution by utilizing the available oxygen during the decomposition of these organisms.

Dam structures over which water flows have beneficial effects of reaeration. It has been noted frequently that the dissolved oxygen content of a stream is usually greater below impoundments. The increase in dissolved oxygen will permit higher pollutional loads to be handled by the stream.

LOUP RIVER BASIN

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LOUP RIVER BASIN

SUMMARY

The Loup River Basin is located in east and central Nebraska. Streams of this system derive their flows almost in their entirety from the Sand Hills Catchment area. The percolating water inflow provides a steady discharge without fluctuations so common to many other streams, although the characteristics of undulating flow become present in the lower reaches where the streams flow through loess soils regions. Climate in the Basin is subhumid with an annual rainfall varying from 18 to 25 inches and extremes in temperature of -40° F. to 115° F. The economy of the Loup River Basin is dependent upon agriculture, poultry, livestock, and food processing. Irrigation is practiced on the North and Middle Loup Rivers. Ord is the sole utilizer of a surface water supply; all other municipalities use ground water. Sources of pollution are moderate and generally discharge to streams having adequate minimum flows except on minor tributaries. All communities should provide a minimum of primary treatment, with secondary treatment where the local situation warrants. Sixteen major reservoir and diversionary structures have been proposed for this Basin for irrigation, hydroelectric power, stream sanitation, fish and wildlife, and recreation. Flow regulation may affect stream sanitation if flow provisions do not take into account the public health and sanitary aspects. The use of sewage polluted waters for irrigation of low-growing fruits and vegetables consumed raw should be discouraged until satisfactory standards for the safe use of such waters are developed; chlorination of sewage plant effluents may be indicated. Desirable flows for public health purposes are presented.

CONCLUSIONS

1. One municipality, Ord, obtains its public water supply from a surface source and furnishes 2,600 people with an average of 300,000 gallons daily. Taste and odor difficulties occur occasionally when an upstream diversion dam located at Burwell is cleaned.

2. There are 42 communities, with a total population of 34,115, using ground sources for public water supplies. The daily consumption averages 5.55 million gallons.

3. The pollution load in the Loup River Basin is not great. Sewage from a population of 25,000 people and industrial wastes with a sewered population equivalent of 10,300, or a total of 35,300 population equivalents, are produced. Existing treatment works reduce this load to 31,410, a reduction of 11 percent.

4. Sixteen percent of the sewered population equivalent is provided with sewage treatment facilities.

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5. The 13 communities now discharging raw wastes should provide a minimum of primary treatment to prevent public health hazards and local nuisances.

6. There are eight potential reservoirs planned for the Loup River Basin. Eight major diversion dams are being contemplated to supplement eight existing diversionary structures.

7. In general, present unregulated minimum flows are adequate for stream sanitation if all municipalities provide a minimum of primary sewage treatment.

8. Table L-10 indicates useful desirable minimum flows at numerous locations on the Loup River and tributaries based upon stream conditions and a minimum of primary sewage treatment at all municipalities. Secondary treatment desirable flows are also presented.

DESCRIPTION

The Loup River Basin, located in east and central Nebraska, contains 14,427 square miles. The main stem is formed by the junction of the North and Middle Loup Rivers near Cushing; the South Loup River joins the Middle Loup River near Boelus. Principal tributaries are listed in table L-1.

Table L-1. Loup River Basin - Principal tributaries and drainage areas

Tributary	Miles above Loup River Mouth	Drainage Area square miles[1]
Loup River		
Beaver Creek	25.1	586
Cedar River	40.0	1,258
North Loup River	67.5	4,145
Calamus River	133.2	1,265
Middle Loup River	67.5	7,567
Dismal River	197.2	1,379
South Loup River	92.7	2,640
Mud Creek	110.7	714

[1] Data from Corps of Engineers

The uniform flow of streams in the Loup River system is derived from percolating waters originating in the Sand Hills area. Surface runoff adds to the stream discharge in eastern Nebraska.

Some 56 communities have populations of 100 or more (table L-2). Nine of these municipalities have more than 1,000 inhabitants while

Table L-2. Loup River Basin - Population of municipalities

Municipality[1]	Population - U. S. Census			
	1920	1930	1940	1949 (Est.)
Albion	1,978	2,172	2,268	2,500
Anselmo	457	472	388	380
Ansley	775	817	753	900
Arcadia	745	711	663	680
Arnold	933	899	884	890
Ashton	397	435	488	500
Bartlett	132	133	176	200
Belgrade	493	386	406	400
Berwyn	205	196	170	176
Boelus	259	246	228	200
Broken Bow	2,567	2,715	2,968	3,534
Burwell	1,214	1,156	1,412	1,700
Calloway	833	833	768	780
Cedar Rapids	766	643	695	578
Columbus	5,410	6,898	7,632	9,300
Comstock	450	450	408	417
Cotesfield	214	153	134	140
Cushing		141	102	100
Dannebrog	436	427	379	395
Dunning	289	212	272	280
Elba	276	286	270	270
Ericson	192	272	279	265
Farwell	337	230	200	210
Fullerton	1,595	1,680	1,707	2,000
Gandy	191	194	169	170
Genoa	1,609	1,089	1,231	1,400
Greeley Center	919	857	891	900
Hazard	167	148	142	140
Litchfield	428	404	412	430
Loup City	1,364	1,446	1,675	2,000
Mason City	467	447	396	410
Merna	553	439	414	530
Monroe	309	293	315	320
Mullen	499	524	725	800
North Loup	637	657	567	600
Oconto	272	243	260	250
Ord	2,143	2,226	2,240	2,500
Palmer	577	588	516	550
Petersburg	501	585	657	650
Pleasanton	262	282	235	230
Primrose	155	210	176	180
Ravenna	1,703	1,559	1,429	1,750
Rockville	208	241	233	322
St. Edward	1,002	1,030	893	940
St. Libory	781	739	142	150
St. Paul	1,615	1,621	1,571	1,700
Sargent	1,078	834	847	900
Scotia	559	474	453	470
Seneca	476	272	255	300
Spalding	878	839	830	850
Stapleton	401	431	399	410
Taylor	251	272	349	460
Thedford	260	270	288	300
Tryon	221	262	120	125
Wolbach	589	501	523	600

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[1] All municipalities listed are in the State of Nebraska.

most of the remaining towns have a population of 500 or less. The agricultural economy is founded upon the production of corn and small grain, livestock and food processing.

Rainfall varies from about 25 inches in the east to 18 inches in the western section of the Basin. Temperature extremes from -40° F. to 115° F. are encountered.

RESERVOIRS AND DIVERSION DAMS

Eight reservoirs are listed in table L-3. The largest are Rockville Reservoir on the Middle Loup River and Davis Creek Reservoir on Davis Creek, with storage capacities of 678,000 and 362,000 acre-feet respectively.

Data regarding the eight proposed[1] diversion dams and eight existing diversion structures, of which two will require rehabilitation, are shown in table L-4 (figures 1 and 3 - General Section). Also indicated in this table are sources of water and diversion destinations.

Existing Dams

Lake Ericson and Lake Babcock, located on Cedar River, are the larger existing impoundments in the Basin. Existing Sargent Diversion Dam directs water from the Middle Loup River to Canals No. 1 and No. 2. Abandonment of this diversion is being considered as part of the development program. Arcadia diversion structure diverts water from the Middle Loup River to Canals No. 3 and No. 4. Newton Diversion Dam in the North Loup directs flow into Newton Ditch. Below Newton existing Almeria, Taylor, Burwell, and Hardenbrook Diversion Dams divert the North Loup River to a system of canals (table L-4). Above Genoa water is diverted by Genoa Diversion Dam from the Loup River to the Loup River Power Canal.

Potential Projects

A review of potential developments as included in the comprehensive plan of the Bureau of Reclamation is presented to indicate the intricacy of the program and the over-all contemplated water use in the Basin. The plan is not final and subject to change contingent upon future developments of the Bureau of Reclamation.

There are no potential storage facilities planned for the South Loup River area (figure 3 - General Section). Flow would be diverted from the South Loup River to Calloway Pumping Plants and canals.

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[1] The words proposed and potential are used interchangeably. In conformance with the interest of the "Comprehensive Plan of the Lower Platte River Basin" of the Bureau of Reclamation, both should bear the portent of the word potential.

Table L-3. Loup River Basin - Reservoir data[1]

Reservoir	Tributary stream	Miles to mouth		Capacity, acre-feet			Status[2]
		Loup River	Tributary stream	Conservation	Inactive	Total	
Loup River							
Loretto	Beaver Creek	25.1	51.0	25,000	21,000	46,000	P
Ericson	Cedar River	40.0	62.3	78,000	5,000	83,000	P
Ericson	Cedar River	40.0	68.4	-	-	-	Ex
Cushing	Spring Creek	66.5	2.0	40,000	5,000	45,000	P
North Loup River							
Davis Creek	Davis Creek	67.5	21.3	355,000	7,000	362,000	P
North Loup Storage [3]	North Loup River	-	-	80,000	8,000	88,000	P
Middle Loup River							
Ashton	Loup River	67.5	44.3	55,000	6,000	61,000	P
Rockville	M. Loup River	67.5	37.1	624,000	54,000	678,000	P
Mullen	M. Loup River	67.5	183.8	50,000	5,000	55,000	P

[1] Date from Bureau of Reclamation

[2] P - Potential reservoirs
Ex - Existing

[3] Location not determined

Table L-4. Loup River Basin - Diversion dam data[1]

Diversion Dam	Tributary	Miles to mouth		Water diverted		Status[2]
		Loup River	Tributary stream	From	To	
Genoa	Loup River	31.3		Loup River	Loup River Power Canal	Ex
Belgrade	Cedar River	40.0	21.0	Cedar River	Belgrade-Genoa Canal	P
St. Paul	Loup River	66.5		Loup River	Central City Canal	P
Cotesfield	North Loup River	67.5	16.8	North Loup River	Fullerton Canal	P
Hardenbrook	North Loup River	67.5	42.5	North Loup River at Ord	Ord-No.Loup Canal and to Potential Scotia Canal	Rh
Burwell	North Loup River	67.5	65.0	North Loup River	Davis Creek Feeder Canal (Existing structures inadequate) Burwell-Sumter Canal	
Taylor	North Loup River	67.5	85.4	North Loup River	Taylor-Ord Canal	Ex
Almeria	North Loup River	67.5	95.7	North Loup River	Canal	Ex
Newton	North Loup River	67.5	105.0	North Loup River	Irrigation Canal	Ex
Turkey Creek	Turkey Creek	67.5	21.6	Turkey Creek	Turkey Creek Feeder Canal	P
Ravenna	South Loup River	67.5	53.2	South Loup River	Feeder Canal to G.I.Canal to Cairo Reg. Res.	P
Cumro	South Loup River	67.5	77.9	South Loup River	South Loup Feeder Canal	P
Arcadia	Middle Loup River	67.5	72.0	Middle Loup River	Canal #3 and #4	Ex
Sargent	Middle Loup River	67.5	86.7	Middle Loup River	Canal #1 and #2	Ex A
Milburn	Middle Loup River	67.5	111.8	Middle Loup River	Sargent Canal, Lillian Canal	P
Dismal River	Dismal River	67.5	144.4	Dismal River	Dismal River Feeder Canal to South Loup	P

[1] Date from Bureau of Reclamation

[2] P - Proposed
Ex - Existing
Rh - Rehabilitation
A - Abandonment

Cumro Diversion Dam would direct water to the Platte Basin by South Loup Feeder Canal. Flow would be diverted from Ash Creek, which would receive water at Dismal River Diversion Dam located across Dismal River, and transported through Dismal Feeder Canal to Anselmo, Victoria, and Merna Canals. Waste flows would be returned to Ash Creek Hydroelectric Plant for the generation of power. Waters emanating from the tailrace of the Ash Creek Plant would be directed to the penstocks of Georgetown Power Plant and wasted to the Georgetown Pumping Plants north of Ash Creek. Potential Ravenna Diversion Dam has been described in the section Platte River and Minor Tributaries.

Proposed Mullen Reservoir would be located on the Middle Loup River east of the town of Mullen in the Sand Hills area. About 70 miles downstream, potential Milburn Diversion Dam would divert flow into potential Sargent and Lillian Canals. Water not needed for irrigation in this area would be carried by Lillian Canal and discharged through potential Lillian Hydroelectric Plant.

Abandonment of existing Sargent Diversion Dam has been proposed. Westcott Canal would divert from the tailrace of Lillian Hydroelectric Plant to supply water to existing Canal No. 1, for irrigating lands in Spring Creek and Clear Creek Valleys, and for the production of power at Lees Park Hydroelectric Plant. Canal No. 2 would be fed by Sargent Canal.

Existing Arcadia Diversion Dam would be replaced by a new structure to supply existing Canal No. 3, and Ashton Feeder Canal which would be constructed with sufficient capacity to irrigate lands now serviced by Canal No. 4.

Water from Westcott Canal would be discharged through potential Lees Park Hydroelectric Plant and returned to the Middle Loup River above Arcadia Diversion Dam. Several laterals and pumping plants would be utilized in Clear Creek Valley to serve lands extending from Westerville to Sweetwater. Sweetwater Pumping Plants and Canals would be used for the application of return flow waters and other waters imported by Lees Park Canal to be accomplished through a group of seven pump diversions and one small relift pump on Clear Creek, and creeks between Hazard and Ravenna.

Ashton Feeder Canal would extend to Oak Creek Valley and discharge into potential Ashton Reservoir. Water not needed for the irrigation of Farwell lands would be sent to potential Rockville Reservoir, passing through potential Austin Power Plant en route. Turkey Creek Diversion Dam and feeder canal would intercept return flows in that stream and make these flows available to Middle Loup lands under the Farwell Mains Canal.

Potential Rockville Reservoir would control and regulate almost completely the flow of the Middle Loup River below Arcadia. Releases from the reservoir would be used to supply potential Boelus Canal and the remainder would be transported by Grand Island Canal to Cairo Regulating Reservoir (Platte River and Minor Tributaries).

North Loup storage is considered under the comprehensive plan to provide seasonal regulation of the waters of the upper North Loup River in order to supplement the direct flow of the river for irrigation. The existing appurtenances directing flow to Newton and Almeria Ditches will be retained. Taylor Diversion Dam will divert water to existing Taylor-Ord Canal. A new diversion structure would replace existing Burwell Diversion Dam to service existing Burwell-Sumter Canal, and potential Davis Creek Feeder Canal, which would in turn supply Dane Creek and Mira Creek Canals and discharge through Pleasant Hill Hydroelectric Plant to Davis Creek Reservoir. Hardenbrook Diversion at Ord would be replaced by a new dam to supply Ord-North Loup and potential Scotia Canals. Releases from Davis Creek Reservoir would be made through Elba Canal for irrigation of lands lying on the west and south sides of the river between Cotesfield and St. Paul. Other releases would be made to potential Davis Creek Hydroelectric Plant to be located below the dam.

Unused flow in the North Loup River and returned waters from Davis Creek Hydroelectric Plant would be available for diversion to Fullerton Canal at potential Cotesfield Diversion Dam. Surplus waters would be diverted to potential Cushing Reservoir for storage and additional flow would be utilized for the generation of hydroelectric power at the Cushing Plant. During the irrigation season primary flow would service those lands located on the north side of the North Loup and Loup River Valleys between Cotesfield and Fullerton.

Potential Cushing Reservoir, located on Spring Creek, would provide the primary supply transported by Central City Canal (Platte River and Minor Tributaries). When necessary this supply would be supplemented by releases from Davis Creek Storage Reservoir, diversion taking place at potential St. Paul Diversion Dam.

Potential Ericson Reservoir will release to potential Spalding North Side Canal, and a lateral would connect to Spalding South Side Canal and cross Cedar River through a siphon.

Above Belgrade a diversion dam would be constructed on Cedar River to divert inflow and return waters as well as releases from potential Ericson Reservoir to Belgrade-Genoa Canal. This canal would extend along the east side of the Cedar River Valley to Fullerton and from these along the north side of the Loup River Valley to existing Genoa Diversion Dam. Two small pumping plants to be built on the west bank of Cedar River near the mouth of Timber Creek would utilize inflow, return water and releases from potential Ericson Reservoir.

Loretto Reservoir would be constructed on Beaver Creek near the town of Loretto. Reservoir releases would supply potential Albion Canal which would extend along the west side of Beaver Creek Valley to St. Edward. Return flows from potential Albion Canal and inflow available at Boone would be lifted by potential Boone Pumping Plant to potential Boone Canal. Surplus waters and stream inflow would be used at St. Edward Hydroelectric Plant and waste waters directed through St. Edward Pumping Plants and Canals for irrigation. An additional area would receive water from Genoa Pumping Plant and Canal System. Return waters and stream flow would be diverted at existing Genoa Diversion Dam above Genoa and would supply existing Loup River Power Canal. A portion of this water would be taken from Loup River Power Canal above existing Monroe Hydroelectric Plant and carried by potential Shell Creek Canal into the north side of Shell Creek Valley. Above existing Lake Babcock potential Platte County Canal would divert an additional flow from the Loup River Power Canal for the purpose of transporting water to Shell Creek Reservoir in addition to servicing tablelands lying between Shell Creek, Loup River Power Canal, and the Platte River.

PRESENTATION OF DATA

Public Water Supplies

Ord is the only community in the Loup Basin (table L-5) utilizing a surface water supply. This city pumps water from the North Loup River, and after treatment serves 2,600 inhabitants with an average supply of 300,000 gallons daily.

Table L-5. Loup River Basin - Municipal surface water supplies

Municipality	Miles above mouth Loup River	Miles above mouth Tributary stream	Population served	Average consumption M. G. D.
North Loup River				
Ord, Nebraska[1]	67.5	50.3	2,600	0.30

[1] Treatment - Aeration, coagulation, sedimentation, filtration, and chlorination.

Forty-two communities obtain public water supplies from ground sources (table L-6). The aquifer which provides these supplies is fed by the Sand Hills Region, one of the great untapped water resources of the State of Nebraska. The supplies are generally adequate and produce water of satisfactory quality. Columbus and Greeley Center treat their water supplies by aeration, coagulation, sedimentation, filtration, and chlorination; Columbus also softens its water. The remainder of the municipalities distribute water without treatment.

Table L-6. Loup River Basin - Municipal water supplies from ground sources

Municipality[1]	Source[2]	Treatment[3]	Population Served	Average Consumption M.G.D.
Albion	W	N	2,000	0.250
Anselmo	W	N	375	0.047
Ansley	W	N	650	0.075
Arcadia	W	N	600	0.070
Arnold	W	N	750	0.060
Ashton	W	N	350	0.030
Bartlett	W	-	175	0.015
Belgrade	W	N	350	0.030
Boelus	W	N	200	0.020
Broken Bow	W	N	3,000	0.500
Burwell	W	N	1,200	0.080
Calloway	W	N	600	0.120
Cedar Rapids	W	N	530	0.100
Columbus	W	ADFH	7,000	2.500
Comstock	W	N	530	0.030
Dannebrog	W	N	400	0.020
Dunning	W	-	-	-
Elba	W	N	250	0.020
Ericson	W	N	130	0.010
Farwell	W	N	150	0.010
Fullerton	W	N	1,500	0.200
Genoa	W	N	1,100	0.090
Greeley Center	W	ADF	800	0.070
Litchfield	W	N	390	0.050
Loup City	W	N	1,550	0.160
Mason City	W	N	350	0.040
Merna	W	N	400	0.040
Monroe	W	N	250	0.020
Mullen	W	N	560	0.040
North Loup	W	N	480	0.030
Palmer	W	N	500	0.050
Petersburg	W	N	480	0.035
Pleasanton	W	N	200	0.025
Primrose	W	N	150	0.010
Ravenna	W	N	1,750	0.300
St. Edward	W	N	750	0.050
St. Paul	W	N	1,500	0.150
Sargent	W	N	700	0.050
Scotia	W	N	320	0.025
Spalding	W	N	700	0.080
Stapleton	W	N	375	0.040
Thedford	W	N	250	0.010
Total			34,115	5.552

[1] All municipalities listed are in the State of Nebraska.

[2] Source - W - Wells.

[3] Treatment - N - None
F - Coagulated, settled, filtered
D - Chlorinated
A - Aeration

Pollution Contributed to Water Resources

Sources of pollution and the magnitude and extent of treatment are given in table L-7. Population equivalents totaling 35,300 are discharged to sewers; 25,000 are domestic sewage contributors and 10,300 represent organic pollutional wastes discharged by industry. One municipality provides primary treatment, 4 cities have secondary treatment facilities, while 13 communities do not treat their wastes. Only 28 percent of the municipalities provide sewage treatment as compared to the national average of 60 percent.

Low-Flow Frequencies

Frequencies of low mean monthly discharges for summer (June-September, inclusive) and winter (December-February, inclusive) have been studied. Minimum mean flows, as well as mean minimum expected discharges occurring once in 2, 3, 5, and 10 years, are presented in tables L-8 and L-9 respectively. The effects of existing diversion dams near Genoa, Ord, Taylor, Burwell, and Arcadia are reflected in the tabulated data.

Low mean monthly flows are normally consequential in estimating the occurrence of critical pollution effects upon streams and sewage treatment must be based upon prevention of these detrimental conditions for reasonable lengths of time. In those cases where developments of water resources depend upon storage and diversion structures for the correct provisions and routing of conserved waters, the need for maintaining the optimum regimen of the stream is great and will influence stream sanitation considerably.

Usually summer conditions are critical. Low flows generally occur, transpiration through plant life is increased, evaporation is enhanced, and high temperatures increase biological activity and reduce the saturation limits of oxygen in water. Greater dilution is then necessary for the maintenance of proper stream conditions. During the winter period lower temperatures with reduced biological activity and higher oxygen levels, coupled with a reduction in the use of water, result in less critical situations. However, in northern climates where streams are frozen over with solid ice cover which prevents reaeration of the stream, oxygen depressions and possibly depletions with accompanying nuisance conditions may occur from the oxidation of organic matter contributed by pollution sources.

With the development program under consideration in the Loup Basin, it is quite possible that the situation might be reversed and critical conditions will occur during winter time when stream flows are being stored for irrigation use during the warmer months of the year. A regulated minimum flow program will do much to prevent the occurrence of public health nuisances.

Table L-7. Loup River Basin - Sources of pollution including industrial wastes expressed as sewered population equivalent (B.O.D.)

Municipality[1]	Miles above Mouth		Industrial Wastes Population Equivalent (B.O.D.)	Population Connected to Sewers	Treatment[2]	Sewered Population Equivalent (B.O.D.)	
	Loup River	Tributary				Untreated	Discharged
Loup River							
Columbus*	0.2		4,270	7,070	N	11,340	11,340
Beaver Creek	25.1						
Genoa		2.6		1,000	N	1,000	1,000
St. Edward		22.6		890	N	890	890
Albion		42.9	265	1,685	N	1,950	1,950
Cedar River	40.0						
Fullerton		2.0	1,745	1,530	N	3,275	3,275
Cedar Rapids		30.9		600	N	600	600
Spalding		53.0		800	N	800	800
Spring Creek	66.5						
Wolbach		10.6		400	S	400	80
North Loup River	67.5						
Ord		50.3	950	1,100	N**	2,050	1,750**
Burwell		64.2	650	800	N	1,450	1,450
Middle Loup River	67.5						
St. Paul		6.6	185	1,710	N	1,895	1,895
Oak Creek		14.9					
Dannebrog		0.6	290	0	N	290	290
South Loup River		25.2					
Ravenna		15.4	570	1,600	N	2,170	2,170
Mud Creek		18.0					
Broken Bow		69.6	470	3,000	S	3,470	1,390
Calloway		100.6		600	P	600	450
Arnold		122.3		900	S	900	225
Loup City		49.1	910	820	N	1,730	1,730
Sargent		86.3		500	S	500	125
Total			10,305	25,005		35,310	31,410

[1] All municipalities listed are located in the State of Nebraska.

[2] Treatment - N - None
P - Primary
S - Secondary

*See Platte River and minor tributaries.

**Industry discharges wastes to pond.

Table L-8. Loup River Basin - Frequency of low mean monthly summer (June - Sept.) discharges[1]

Years of Record	Stream and Location[2]	Miles to Mouth		Drainage Area Square Miles	Minimum Monthly Mean Flows in cubic feet per second that may be expected once in:				
		Loup River	Tributary		2 years	3 years	5 years	10 years	Minimum[3]
	Loup River								
15*	Columbus	0.2		14,200	780	220	180	108	76
15*	Genoa	26.9			640	77	54	0	0
	Beaver Creek	26.1							
15*	Genoa		2.6		64	51	46	40	37
15*	Boone		31.4		44	39	37	30	30
15*	Loretto Damsite		50.6		28	27	25	25	22
	Cedar River	40.0							
15*	Fullerton		6.2		130	130	120	97	94
15*	Ericson Damsite		62.3		91	84	80	77	74
15*	Ericson		69.9		62	57	56	52	50
	North Loup River	67.5							
14^H	Near St. Paul)		3.5	4,040	480	420	300	240	220
14^N	" " ")		3.5	4,040	590	510	480	460	440
14*	Near Ord		80.3		610	600	590	580	470
14*	Burwell		75.6		590	580	560	540	580
14*	Taylor		87.6		480	420	390	300	340
14*	Brewster Damsite		117.0		240	220	220	200	190
	Davis Creek	67.5							
14*	Near Cotesfield		22.5		3	3	2	2	2
	Middle Loup River	67.5							
14	St. Paul		3.5	7,320	680	600	580	480	360
19*	Arcadia		72.0		670	650	640	620	580
19*	Milburn Damsite		111.8		710	700	690	680	660
19*	Mullen Damsite		188.6		180	180	180	180	160
	Dismal River	67.5							
15^{H*}	Dismal River Div. Dam		144.4		270	270	270	270	280
15^{N*}	" " " "				240	240	220	210	210
	South Loup River	67.5							
15*	St. Michael		33.0		130	120	110	110	96
15*	Ravenna		41.2		110	100	96	86	74
15*	Near Cumro		86.7		67	64	61	60	57
15*	Callaway		125.8		39	32	31	30	30
	Mud Creek	67.5							
15*	Near Ravenna		43.8		18	18	18	15	12

Table L-9. Loup River Basin - Frequency of low mean monthly winter (Dec. - Feb.) discharges[1]

Years of Record	Stream and Location[2]	Miles to Mouth		Drainage Area Square Miles	Minimum Monthly Mean Flows in cubic feet per second that may be expected once in:				
		Loup River	Tributary		2 years	3 years	5 years	10 years	Minimum[3]
	Loup River								
15*	Columbus	0.2		14,200	1,100	710	560	500	150
15*	Genoa	26.9			900	670	460	310	0
	Beaver Creek	26.1							
15*	Genoa		2.6		74	72	72	70	60
15*	Boone		31.4		56	56	54	50	45
15*	Loretto Damsite		50.6		42	42	38	30	27
	Cedar River	40.0							
15*	Fullerton		6.2		170	170	160	150	150
15*	Ericson Damsite		62.3		110	110	100	99	91
15*	Ericson		69.9		74	74	71	67	62
	North Loup River	67.5							
14^H	Near St. Paul		3.5	4,040	560	540	530	520	500
14^N	" " "		3.5	4,040	620	600	560	560	550
14*	Near Ord		80.3		630	650	530	500	430
14*	Burwell		75.6		680	620	550	570	250
14*	Taylor		87.6		350	350	340	310	290
14*	Brewster Damsite				300	250	260	260	250
	Davis Creek	67.5							
14*	Near Cotesfield		22.5		2	2	2	2	2
	Middle Loup River	67.5							
14	St. Paul		3.5	7,320	780	720	660	570	500
19*	Arcadia		72.0		700	680	590	440	370
19*	Milburn Damsite		111.8		720	700	680	670	570
19*	Mullen Damsite		188.6		180	180	180	150	130
	Dismal River	67.5							
15^{H*}	Dismal River)				270	270	270	280	260
15^{N*}	Diversion Dam)		144.4		260	250	220	210	190
	South Loup River	67.5							
15*	St. Michael		33.0		160	160	160	160	160
15*	Ravenna		41.2		140	140	140	140	130
15*	Near Cumro		86.7		92	92	91	87	86
15*	Callaway		125.8		85	84	84	84	80
	Mud Creek	67.5							
15*	Near Ravenna		43.8		18	18	18	15	8

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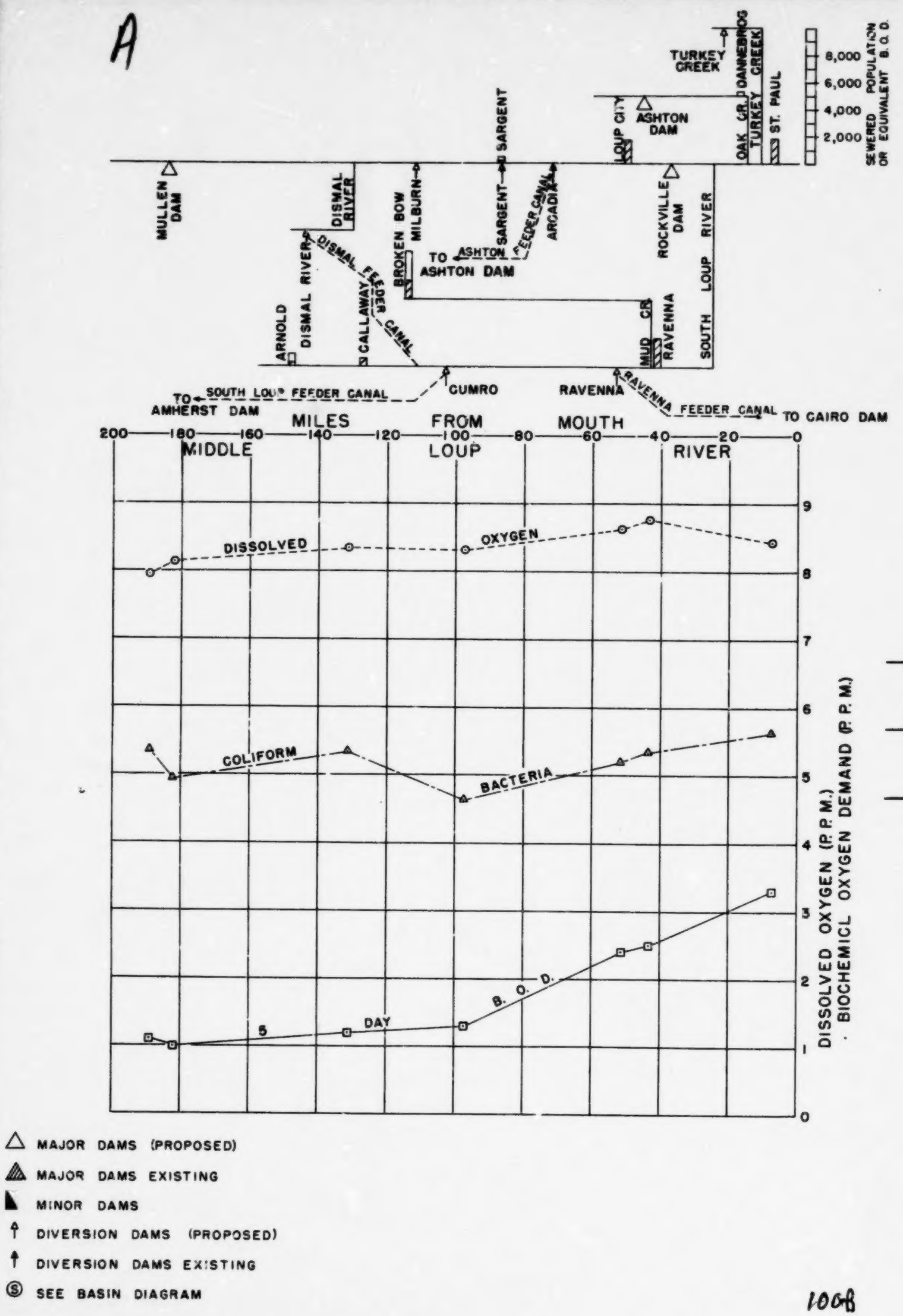
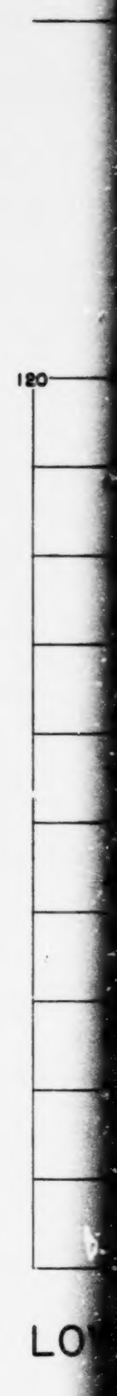
[1] Based on data obtained from Bureau of Reclamation.
[2] All streams and municipalities located within State of Nebraska.
[3] Low mean month.
*From records and estimates correlated with other flow data.
H - Historical flow.
N - Natural flow.

A



TURKEY CREEK
OAK CR.
DANNEBROG
TURKEY CREEK
ST. PAUL
8,000
6,000
4,000
2,000
SEWERED POPULATION OR EQUIVALENT B.O.D.
SARGENT
LOUP CITY
ASHTON DAM
MULLEN DAM
DISMAL RIVER
MILBURN
BROKEN BOW
SARGENT
ASHTON FEEDER CANAL
SARGENT FEEDER CANAL
ARCADIA
ROCKVILLE DAM
SOUTH LOUP RIVER
TO ASHTON DAM
DISMAL RIVER
DISMAL FEEDER CANAL
ARNOLD
CALLAWAY
MUD CR.
RAVENNA
CUMRO
RAVENNA
RAVENNA FEEDER CANAL
TO CAIRO DAM
TO AMHERST DAM
SOUTH LOUP FEEDER CANAL
MILES FROM MOUTH
200
180
160
140
120
100
80
60
40
20
0
MIDDLE LOUP RIVER
DISSOLVED OXYGEN
COLIFORM BACTERIA
5 DAY B. O. D.
9
8
7
6
5
4
3
2
1
0
DISSOLVED OXYGEN (P.P.M.)
BIOCHEMICL OXYGEN DEMAND (P.P.M.)
50,000
10,000
5,000
1,000
500
100
COLIFORM BACTERIA PER 100 ML.
△ MAJOR DAMS (PROPOSED)
▲ MAJOR DAMS EXISTING
◣ MINOR DAMS
↑ DIVERSION DAMS (PROPOSED)
↑ DIVERSION DAMS EXISTING
Ⓢ SEE BASIN DIAGRAM



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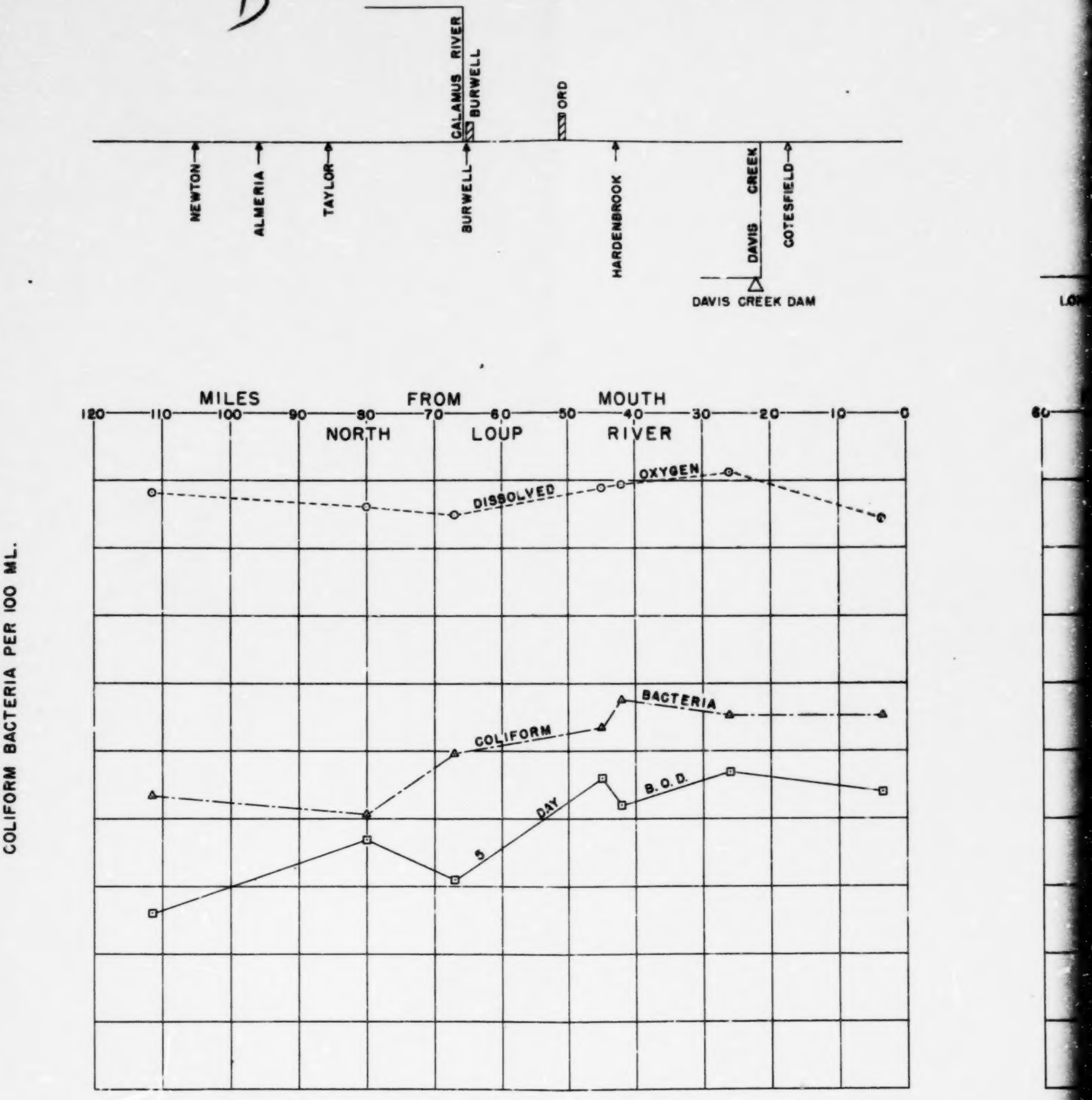


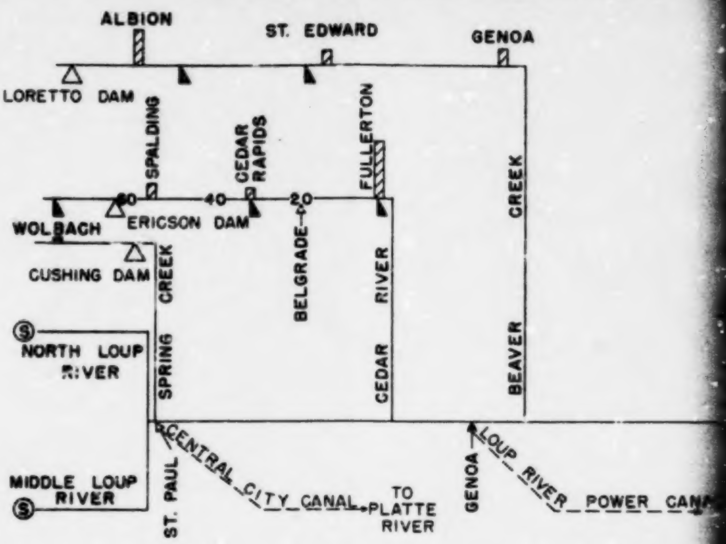
LOWER PLATTE RIVER BASIN

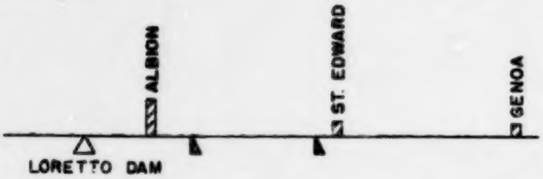
WATER POLLUTION INVESTIGATION

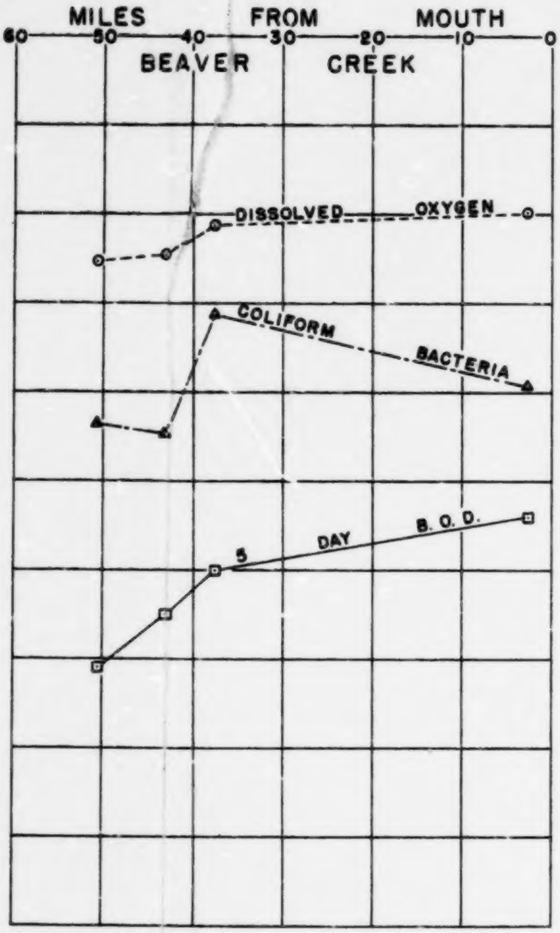
U. S. PUBLIC HEALTH SERVICE

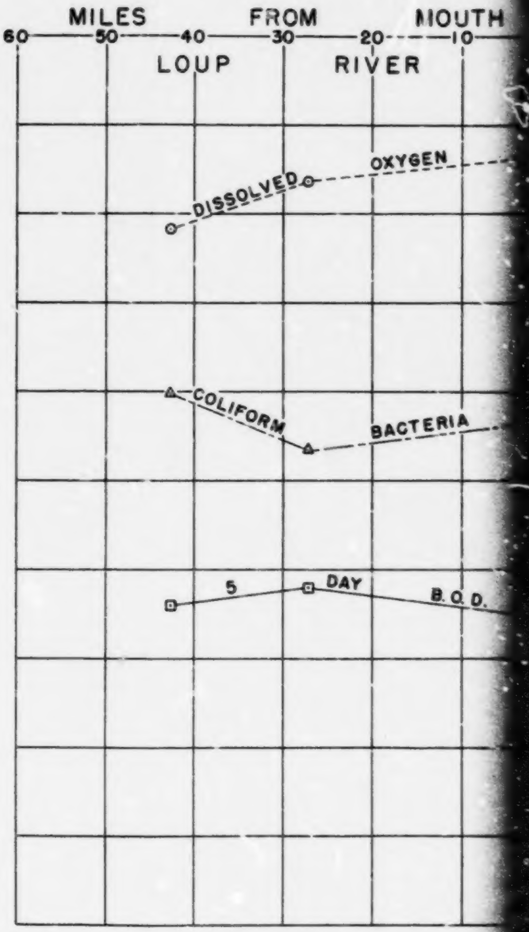
1950

C









OLLUTION REMOVED
Y TREATMENT

OLLUTION DISCHARGED

△ MAJOR DAMS (PROPOSED)

▲ MAJOR DAMS EXISTING

◣ MINOR DAMS

↑ DIVERSION DAMS (PROPOSED)

↑ DIVERSION DAMS EXISTING

Ⓢ SEE BASIN DIAGRAM

LOUP RIVER & T

SOURCES OF POL

AND

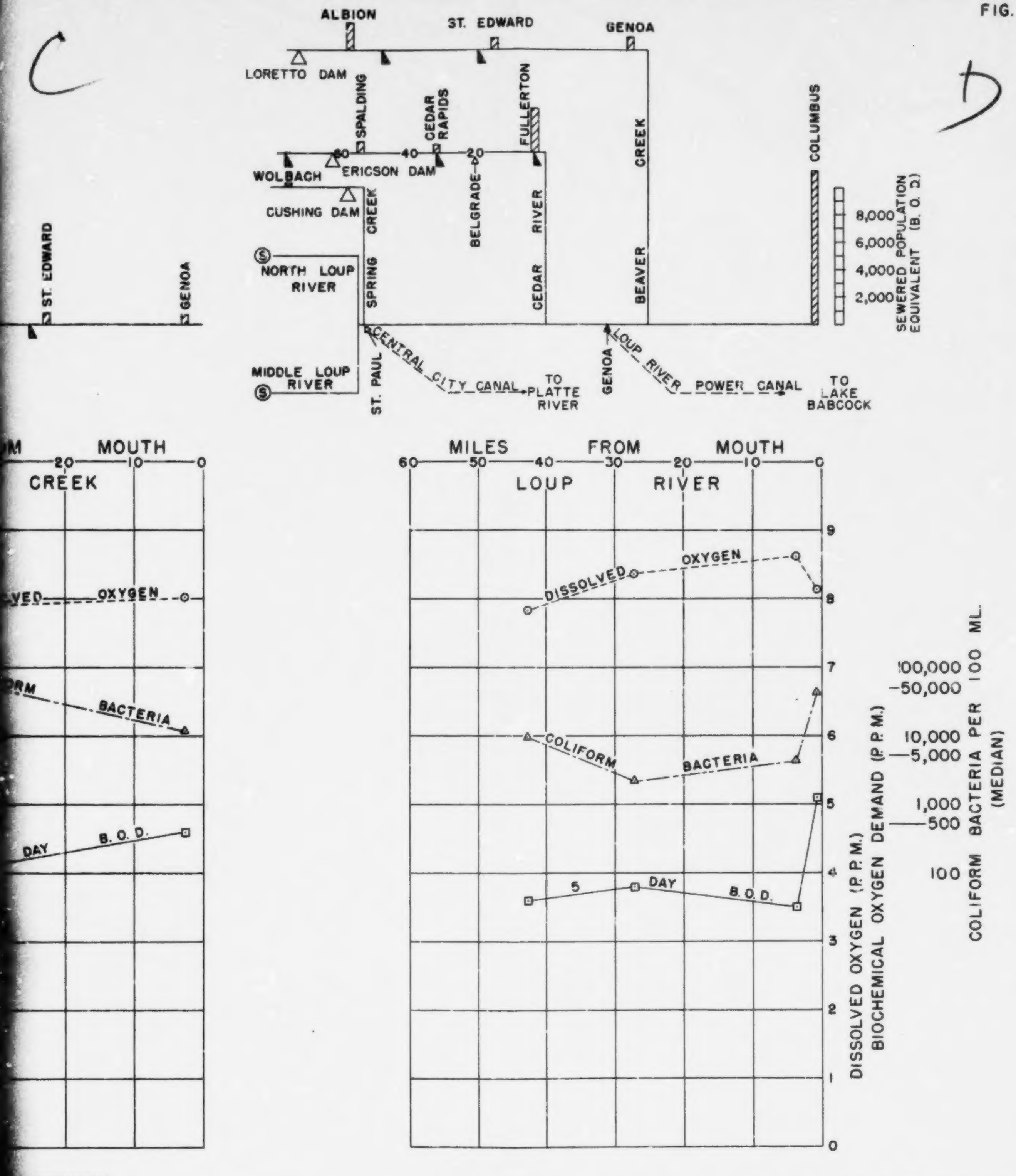
AVERAGE LABORATOR

APRIL, MAY, JUNE, JU

FIG. L-1

C

D



(PROPOSED)

EXISTING

MS (PROPOSED)

MS EXISTING

AGRAM

LOUP RIVER & TRIBUTARIES

SOURCES OF POLLUTION

AND

AVERAGE LABORATORY RESULTS

APRIL, MAY, JUNE, JULY / 1949

Laboratory Results

Average or median results of laboratory analyses are presented, together with sources of pollution and existing and proposed diversion and storage dams, in figure L-1. A summary of the individual laboratory results is included in appendix G.

The Loup River (figure L-1) showed satisfactory dissolved oxygen content throughout. Moderate pollution below Ord was indicated by a B.O.D. of 4.0 ppm. and a coliform count of 5900/100 ml. The presence of moderate pollution below Columbus was noted by an increase in the coliform count and B.O.D.

Beaver Creek showed a satisfactory dissolved oxygen content; the average B.O.D. was moderate and did not exceed 4.6 ppm., while a high coliform count consistently above 10,000/100 ml. was recorded below Albion outfall sewer.

Analyses of Cedar River samples reflected significant coliform counts of about 10,000/100 ml. A minimum dissolved oxygen value of 7.6 ppm. and a maximum B.O.D. of 4.3 ppm. did not indicate a serious pollution problem.

Average laboratory data of samples collected from the Middle Loup River are also shown in figure L-1. Dissolved oxygen and B.O.D. values in the Middle Loup River indicate slight to moderate pollution which is substantiated by the median coliform count of 5,000/100 ml. Light pollution was indicated in the South Loup River. The dissolved oxygen diminished slightly below the point of raw waste discharge from Ravenna. Although the B.O.D. was not high, less than 4 ppm., significant coliform counts of 10,000/100 ml. or over appeared as the best index of moderate pollution.

DISCUSSION

Municipal Water Supplies

Municipalities in this Basin, with the exception of Ord, secure public water supplies from ground sources. The supply is adequate and generally provides a water of satisfactory quality. Water is distributed in most instances without treatment, Columbus and Greeley Center being the only towns that filter and chlorinate their supplies. The ground water supply at Albion is affected by iron and manganese and also contains hydrogen sulphide; this water is not treated.

The North Loup River supplies Ord with its water which is filtered and chlorinated prior to distribution. Clean-up operations at the upstream Burwell Diversion Dam cause occasional taste and odor difficulties in Ord's water supply that are controlled to a reasonable degree by post-chlorination. The water intake is located on the right bank of the river approximately 950 feet downstream from a slaughterhouse sewer outfall discharging from the left bank. It is claimed that ill effects are minimized by the direction and velocity of the current, and the location of Anderson Island which tends to divert the industrial waste from the water intake. The effect of future low flow regulation on this situation should be carefully observed.

Burwell discharges sewage to the stream about 12 miles upstream from Ord's water plant intake, and excessive reduction in flow would create a hazard to this water supply. Some consideration is being given by Ord to the possibility of utilizing, as the source of public supply, water that would be diverted from Burwell Diversion Dam by an irrigation canal.

Industrial uses are limited to cooling, air-conditioning, and cleaning waters for those industries such as poultry dressing, dairy, and meat-packing. The present industrial demand is not as great as in the main Platte and Elkhorn Basins where the communities are generally larger and more highly developed industrially.

Irrigation Water Quality

The comprehensive plan of the Bureau of Reclamation includes present irrigation facilities with improvements or modifications, a discussion of which has been presented in the section on Dams and Reservoirs. Irrigation water may include discharged wastes, both raw and treated, and the public health significance of the contaminated waters must not be overlooked. Reference is made to appendix D, "Partial Review of Literature on Public Health Aspects of Irrigation with Sewage Polluted Water."

Sources of Pollution and Status of Sewage Treatment

Sources of pollution in the Loup River system are smaller than those encountered on the Platte and Elkhorn Rivers, and generally discharge to streams having adequate minimum flows for the assimilation of the treated residual wastes. This condition reflects the predominantly rural characteristics of the area with small communities which are not highly industrialized.

As depicted in table L-7, 18 municipalities discharge sewage into streams of the Loup River Basin; 1 community, Calloway, has a primary treatment plant; 4 municipalities--Wolbach, Broken Bow, Arnold, and Sargent--treat their sewage by a secondary process. The remaining communities discharge raw wastes to the streams.

Stream Conditions and Sewage Treatment Needs

The condition of streams in the Basin is generally good. The area is agricultural in character; communities are not large in size and are not highly industrialized. At present eight diversion dams are in operation for the purpose of irrigating agricultural areas. The development plan recommends the construction, operation, and maintenance of eight major reservoirs and eight major diversion dams to serve in the direction and regulation of water for the prime purpose of irrigation. The degree of sewage treatment required is founded on existing conditions, including downstream uses and expected normal low flows. The present evaluation reflects conditions observed during the field and laboratory study and does not consider the flows that may develop as a consequence of the development program.

A minimum of primary treatment is indicated for St. Paul and Loup City on the Middle Loup River, Ravenna on the South Loup River, and Ord on the North Loup. Similar treatment is also required at Spalding, Cedar Rapids, and Fullerton on Cedar River, and the same degree of treatment is recommended for the municipalities of Albion, St. Edward, and Genoa which discharge to Beaver Creek. Columbus has been discussed as a Platte River problem.

Secondary treatment and chlorination may be required at Burwell to protect Ord's water supply. However, should Ord take its water supply from an irrigation canal a lesser degree of treatment may suffice.

Adequate secondary treatment, assuming efficient operation, is provided by Sargent, Arnold, Broken Bow, and Wolbach. The existing treatment plant at Calloway appears adequate.

Flow Needs: Benefits and Damages

Estimates of useful desirable flows have been based upon a minimum of primary treatment, stream conditions during the summer period, and a minimum oxygen level of 5.0 ppm. Secondary treatment desirable flows assume the same stream conditions and effective secondary sewage treatment.

Unregulated minimum flow in streams of the Loup River Basin are generally in excess of the specified useful desirable flows and, accordingly, no monetary benefits may be accredited to the development program for providing the required flows (table L-10). However, should the diversion program reduce the flows to the extent that they are below the recommended desirable minimums, damages to the communities in the form of higher treatment requirements would result. Preliminary flow estimates and possible damages are also shown in table L-10. Reduced flows resulting from development of the comprehensive program would make necessary a higher degree of treatment at Ravenna and Burwell.

Flow needs during other seasons of the year will vary with water temperature and are presented as percentages of the summer period flows in table 10, General Section.

Table L-10. Loup River Basin - Flow needs and cost evaluation

Municipality	Stream	Approximate Miles from Mouth Loup	Approximate Miles from Mouth Tributary	Minimum Normal Flow c.f.s.	Useful Desirable Minimum Flow[1] c.f.s.	Secondary Treatment Desirable Minimum Flow c.f.s.	Necessary to Prevent Damage to Municipality	Annual Tangible Monetary Benefits Possible if Flow in Column 6 is Provided	Preliminary Estimate Minimum Mean Monthly Flow Under Proposed Flow Regulation Program	Annual Tangible Benefits (≠) and Damages (-) Under Proposed Flow Regulation Program (Estimated Flow in Column 10)
1	2	3	4	5	6	7	8	9	10	11
Sargent	Middle Loup	67.5	86.3 -	625[2]	1[3]	1	1	0	141	$ 0
Loup City	Middle Loup		49.1	500[2]	7	3	7	0	10	0
Calloway	South Loup		-100.6	30	4	2	4	0	-	-
Ravenna	South Loup		- 15.4	86	8	4	8	0	5	-2,400
Dannebrog	Oak Creek		14.9-0.6	-	1.5	1	1.5	0	-	-
St. Paul	Middle Loup		6.6	450	12	5	12	0	119	0
Burwell	North Loup	67.5	64.2	540	5	2	5	0	0	-2,200
Ord	North Loup		50.3	550	8	3	8	0	-	-
Wolbach	Spring Creek	66.5	10.6	-	1[3]	1	1	0	-	-
Spalding	Cedar River	40.0	55.0	77[2]	3	2	3	0	10[2]	0
Cedar Rapids	Cedar River		30.9	88[2]	4	2	4	0	30[2]	0
Fullerton	Cedar River		2.5	97	15	7	15	0	20	0
Albion	Beaver Creek	25.1	42.9	25[2]	7	3	7	0	7[2]	0
St. Edward	Beaver Creek		22.6	30[2]	7	3	7	0	20[2]	0
Genoa	Beaver Creek		2.6	40	4	2	4	0	8[2]	0
Columbus	Loup River	0.2		102	50	22	50	0	77	0

[1] Based on primary treatment

[2] Estimate

[3] Secondary treatment plant in operation

Effect of Reservoirs on Pollution Assimilation Capacity of Streams

Reservoirs affect a reduction in pollution by providing large volumes for dilution, and increasing time of passage thus permitting further biological action and settling of organic matter as a result of decreased stream velocities. However, the settling effect may cause localized nuisances by the building up of sludge banks which would utilize the available oxygen in the surrounding waters. Settling and clarification of waters in reservoirs permit further penetration of sunlight and increase development of algae. These algae growths may cause taste and odor problems to downstream surface water supplies while decomposition of excessive growth may pollute the lower reaches.

Flow over spillways and tailrace structures results in a high degree of reaeration enabling a stream to assimilate greater pollutional loads which are quite significant in many instances.

Effect of Reservoir Backwater - The development plan by the Bureau of Reclamation indicates that the town of Wolbach might be adversely affected by the reservoir pool. Backwater from Cushing Reservoir on Spring Creek may inundate the present sewage plant and appurtenances, or reduce the flow of the stream, thereby enhancing sedimentation with the possibility of creating a local nuisance. A possible damage may occur as the result of a higher degree of treatment needed.

Further consideration is indicated regarding backwater at Rockville Reservoir and its possible effect upon the outfall sewer of Loup City located on the Middle Loup River.

ELKHORN RIVER BASIN

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ELKHORN RIVER BASIN

SUMMARY

The Elkhorn River, located in northeastern Nebraska and draining an area of 6,800 square miles, is tributary to the Platte River. The subhumid climate in the Basin is characterized by a moderate annual rainfall which decreases from east to west and by extremes in temperature. Economically the Basin depends largely upon agriculture and the production of livestock and associated products. Well irrigation has been practiced to a very limited degree. All municipalities obtain public water supplies from adequate ground sources. Pollutional discharges to the Elkhorn River and tributaries have caused nuisances and public health hazards. All communities should provide a minimum of primary treatment and a higher degree of treatment where necessary. One potential storage reservoir and eight potential diversion dams are included in the development plan for the Elkhorn River Basin and will affect stream sanitation conditions, particularly where regulated flows are less than the useful desirable minimum mean flow. The development program should consider public health and stream sanitation aspects and should caution against the use of sewage-infected water for the irrigation of low-growing crops which are consumed raw until satisfactory standards have been developed for the safe use of such waters. Desirable mean minimum flows for public health purposes and evaluations of flow variations are presented.

CONCLUSIONS

1. Forty-seven municipalities in the Elkhorn River Basin use ground sources for public water supplies serving 44,935 people with 4.99 million gallons daily. No municipalities use surface sources for public water supplies.

2. The Basin has a total sewered population equivalent of 116,160, of which 58,430 represent domestic sewage and 57,730 the waste contribution of industry. A reduction of 3.5 percent is effected by treatment. Thirty-two percent of the municipalities possess treatment facilities.

3. One storage reservoir and eight potential diversion dams are included in the Elkhorn River Basin development program.

4. Eleven new primary and two new secondary treatment plants are required on the main stem, and two new primary plants and eight new plants with secondary treatment facilities are needed at municipalities discharging raw sewage to streams tributary to the Elkhorn River. Improvements to four additional plants involve a progression from primary to secondary treatment.

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5. In general unregulated normal minimum monthly mean flows in the Elkhorn River are adequate if all communities, with the exception of O'Neill and Norfolk, provide a minimum of primary sewage treatment. O'Neill and Norfolk should provide secondary sewage treatment.

6. Desirable minimum flows are presented in table E-9 for a number of municipalities located on the Elkhorn River and tributaries, and are based upon the sanitation needs and a minimum of primary treatment. Also tabulated are desirable minimum flows for secondary treatment.

7. Annual tangible monetary benefits and damages are provided in table E-9 based upon possible changes in minimum monthly mean flows resulting from the potential flow regulation program.

DESCRIPTION

The Elkhorn River, draining 6,800 square miles, rises in the Sand Hill area and flows generally southeast to its confluence with the Platte River near Gretna. Principal tributaries are listed in table E-1.

Table E-1. Elkhorn River Basin - Principal tributaries and their drainage areas

Tributary	Miles above Elkhorn River mouth	Drainage area[1] square miles
Elkhorn River		
Bell Creek	24.7	196
Maple Creek	34.8	398
Logan Creek	43.8	1,031
Pebble Creek	53.1	212
Cuming Creek	54.3	101
Plum Creek	79.9	166
Union Creek	128.7	356
North Branch Elkhorn River	141.8	829
Battle Creek	156.7	93
South Fork Elkhorn River	210.1	400

[1] Data from Corps of Engineers

The Basin had a 1940 population approximating 146,700, of which 30,100 was urban and 116,600 rural. The population density varied from 4 persons per square mile in Garfield County to 78 persons per square mile in Douglas County; the average population density of the Basin as a whole was about 22 persons per square mile. The population increase was steady to 1930, but the following decade saw a decrease of about 6.1 percent. Since 1940 a slight rise has been noted in most communities. The City of Norfolk, the only Basin city with a population in excess of 5,000, showed an estimated 13,000 in 1949 as compared with a 1940 census figure of 10,490. Fourteen communities have 1,000 or more inhabitants; 41.6 percent have populations of 500-999; 30.1 percent 1,000 or over; and 28.3 percent have less than 499. The populations of municipalities within the Elkhorn River Basin are provided in table E-2.

The production of livestock, corn, small grains, and poultry forms the basis of an agricultural economy which has been developed to a high degree. Industrial growth has been limited to processing livestock and agricultural products.

The Elkhorn River Basin has a subhumid climate characterized by moderate precipitation and extremes in temperature. In the eastern regions the annual precipitation is about 28 inches which decreases in the west to about 18 inches. Most of the precipitation occurs as rainfall during the growing season and snowfall is moderately heavy.

RESERVOIRS AND DIVERSION DAMS

There are no existing major reservoirs or diversion dams in the Basin.

Potential Projects

A review of potential developments as included in the comprehensive plan of the Bureau of Reclamation is presented to indicate the intricacy of the program and the over-all contemplated water use in the Basin. The plan is not final and is subject to change contingent upon future developments of the Bureau of Reclamation.

Planned diversion of flow from the Elkhorn River is primarily for the development of irrigation (figures 1 and 3 - General Section). Rosedale Reservoir, to be located upon Clearwater Creek, is the only potential storage structure in the Basin. Discharge of the Elkhorn River would be diverted at Ewing Diversion Dam to the Rosedale Feeder Canal which would flow into Rosedale Reservoir. Water diverted from the South Fork of the Elkhorn River would add to the discharge of the feeder canal. Neligh Diversion Dam would divert water to the Neligh Pumping Plant and Canal for use in irrigation.

At Rosedale Reservoir, Clearwater Canal would receive water for irrigating land south of the canal. Cedar Creek Canal would be fed waters diverted at Cedar Creek Diversion Dam above Oakdale. Downstream, Battle Creek Diversion Dam would feed water for irrigating land extending along the north side of the valley to Norfolk. Norfolk Canals extending along both banks of the Elkhorn River would be serviced by Norfolk Diversion Dam. Near Stanton, Union Creek Diversion Dam would supply Union Creek Canal to serve lands on the north side of the river.

Table E-2. Elkhorn River Basin - Population of municipalities

Municipality[1]	Population - U. S. Census 1920	1930	1940	1949 (Est.)
Arlington	695	622	569	650
Atkinson	1,300	1,144	1,350	1,400
Bancroft	673	660	599	610
Bassett	664	635	931	1,450
Battle Creek	743	755	702	725
Beemer	548	571	585	600
Brunswick	359	352	289	296
Carroll	448	401	351	375
Chambers	256	259	388	390
Clarkson	884	918	829	850
Clearwater	479	504	568	580
Dodge	648	693	656	700
Elgin	854	917	853	950
Emmett	130	88	89	90
Ewing	543	588	681	900
Hooper	1,014	985	802	825
Hoskins	274	255	212	220
Howells	904	952	861	875
Humphrey	835	854	841	850
Inman	315	285	206	210
Leigh	516	692	575	595
Lyons	1,025	985	1,033	1,030
Madison	1,735	1,842	1,812	2,000
Meadow Grove	449	483	479	500
Neligh	1,724	1,649	1,796	2,200
Newport	430	273	275	280
Nickerson	141	183	159	165
Norfolk	8,634	10,717	10,490	13,000
Oakdale	707	663	561	550
Oakland	1,356	1,433	1,380	1,400
O'Neill	2,107	2,019	2,532	3,000
Orchard	-	-	493	500
Pender	992	1,006	1,135	1,400
Pierce	1,105	1,271	1,249	1,260
Pilger	563	578	537	550
Randolph	1,338	1,145	1,094	1,110
Rosalie	321	279	250	270
Royal	202	217	193	200
Scribner	1,021	1,066	904	910
Sholes	50	90	72	81
Snyder	359	458	395	410
Stanton	1,487	1,479	1,526	1,580
Stuart	739	763	760	900
Tilden	1,101	1,106	984	980
Uehling	267	297	253	280
Valley	764	1,039	985	1,000
Wakefield	1,114	1,112	961	990
Waterloo	431	432	381	399
Wayne	2,115	2,381	2,719	3,300
West Point	2,002	2,225	2,510	2,900
Winside	488	483	451	500
Winslow	154	156	130	135
Wisner	1,210	1,327	1,256	1,400

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[1] All municipalities listed are in the State of Nebraska

Potential development of Shell Creek Reservoir has been covered in the main Platte Basin. Flow from this reservoir would be diverted through Schuyler Canal to supplement waters diverted at Hooper Diversion Dam to add to erratic seasonal flows of the Elkhorn River for use in irrigating the area contained in the Plattehorn Division. This water would be transported in Fremont Canal along the west side of the Elkhorn River Valley to Fremont and would then continue southeast on the Platte-Elkhorn divide to the confluence of Platte and Elkhorn Rivers. Whenever necessary additional water would be released for irrigation from Shell Creek Reservoir.

In a study of flood conditions in the Elkhorn River Basin conducted by the Army Engineers, a flood control reservoir has been included at Scribner. The report[*] states that the plan offered is not warranted for adoption as costs of improvement would be in excess of the benefits derived.

Reservoir and diversion dam data are included in tables E-3 and E-4.

Table E-3. Elkhorn River Basin - Reservoir data[1]

Reservoir[2]	Miles to mouth		Capacity, acre-feet			
	Elkhorn River	Tributary stream	Conservation	Inactive	Total	Status[3]
Rosedale	199.5	4.0	60,000	5,000	65,000	P

[1] Data from Bureau of Reclamation
[2] Located on Clearwater Creek
[3] P - Proposed

PRESENTATION OF DATA

Public Water Supplies

All municipal water supplies are derived from ground sources. The water is generally distributed without treatment although Arlington, Lyons, Norfolk, and Oakland have treatment facilities consisting of aeration, coagulation, and filtration. Municipal Water Supply table E-5 shows a total of 44,935 people with a daily consumption of about 4.99 million gallons supplied by wells. Norfolk, with a demand of 1.15 million gallons daily, is the largest consumer.

Pollution Contributed to Water Resources

Data presented in table E-6 include the population connected to sewers, contributions by industry in terms of population equivalents,

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[*] Elkhorn River and Tributaries, Nebraska House Document No. 215 - 81st Congress. Corps of Engineers.

Table E-4. Elkhorn River Basin - Diversion dam data[1]

Diversion Dam	Miles to mouth: Elkhorn River	Miles to mouth: Tributary stream	Water diverted: From	Water diverted: To	Status[2]
Hooper	44.2		Elkhorn River	Fremont Canal	P
Union Creek	127.2		Elkhorn River	Union Creek Canal	P
Norfolk	144.0		Elkhorn River	Norfolk Canal No. 1 Norfolk Canal No. 2	P P
Battle Creek	158.0		Elkhorn River	Battle Creek Canal	P
Cedar Creek	184.7		Elkhorn River	Cedar Creek Canal	P
Neligh	197.8		Elkhorn River	Neligh Canal Neligh Pumping Station	P
South Fork Elkhorn	210.1	4.5	South Fork Elkhorn River	Rosedale Feeder Canal	P
Ewing	214.5		Elkhorn River	Rosedale Feeder Canal to Reservoir	P

[1] Data from Bureau of Reclamation

[2] P - Proposed

type of treatment, and population equivalents discharged to streams. The source of the pollution is designated by river miles above the mouth of the streams.

A sewered population of 58,430, plus an estimated industrial waste of 57,730 population equivalents, is reduced by treatment to 112,210, or a reduction of 3-1/2 percent. Population equivalents totaling 102,590 contributed by 19 municipalities, or 88 percent of the total pollution load produced in the Basin, are discharged to streams without treatment.

Six municipalities possess primary treatment facilities credited with a treatment efficiency of 35 percent which discharge 2,680 population equivalents into streams. Four communities utilize septic tanks which provide ineffective treatment and discharge wastes equivalent to a population of 5,030. Five communities reduce 4,960 population equivalents, an estimated 60 percent, by secondary treatment plants to discharge 1,900 population equivalents to receiving bodies of water. An industrial plant at Waterloo has a secondary treatment plant.

Table E-5. Elkhorn River Basin - Municipal water supplies from ground sources

Municipality[1]	Source[2]	Treatment[3]	Population served	Average Consumption M. G. D.
Arlington	W	AF	600	0.20
Atkinson	W	N	1,100	0.15
Bancroft	W	N	575	0.060
Bassett	W	N	640	0.075
Battle Creek	W	N	600	0.05
Beemer	W	N	450	0.035
Brunswick	W	N	250	0.025
Carroll	W	N	310	0.03
Clarkson	W	N	750	0.07
Clearwater	W	N	400	0.03
Dodge	W	N	600	0.07
Elgin	W	N	800	0.07
Ewing	W	N	700	0.06
Hooper	W	N	700	0.08
Hoskins	W	N	150	0.015
Howells	W	N	800	0.08
Humphrey	W	N	730	0.07
Leigh	W	N	500	0.05
Lyons	W	AFH	1,000	0.10
Madison	W	N	1,750	0.30
Meadow Grove	W	N	400	0.025
Neligh	W	N	1,675	0.20
Newport	W	N	150	0.001
Norfolk	W	AF	10,000	1.15
Oakdale	W	N	440	0.025
Oakland	W	AF	1,200	0.15
O'Neill	W	N	2,300	0.30
Orchard	W	N	450	0.075
Pender	W	N	960	0.125
Pierce	W	N	830	0.08
Pilger	W	N	350	0.020
Rosalie	W	N	200	0.015
Royal	W	N	130	0.005
Scribner	W	N	700	0.10
Snyder	W	N	290	0.03
Stanton	W	N	1,300	0.10
Stuart	W	N	600	0.050
Tilden	W	N	850	0.032
Uehling	W	N	200	0.015
Valley	W	N	880	0.15
Wakefield	W	AF	1,175	0.10
Waterloo	W	N	380	0.020
Wayne	W	N	2,500	0.270
West Point	W	N	2,000	0.180
Winside	W	N	350	0.035
Winslow	W	N	120	0.015
Wisner	W	N	1,100	0.10
Total			44,935	4.988

[1] All municipalities listed are located in the State of Nebraska

[2] Source - W - Wells

[3] Treatment - N - None

F - Coagulated, settled, filtered

H - Softened

A - Aeration

Table E-6. Elkhorn River Basin - Sources of pollution including industrial wastes expressed as sewered population equivalent (B.O.D.)

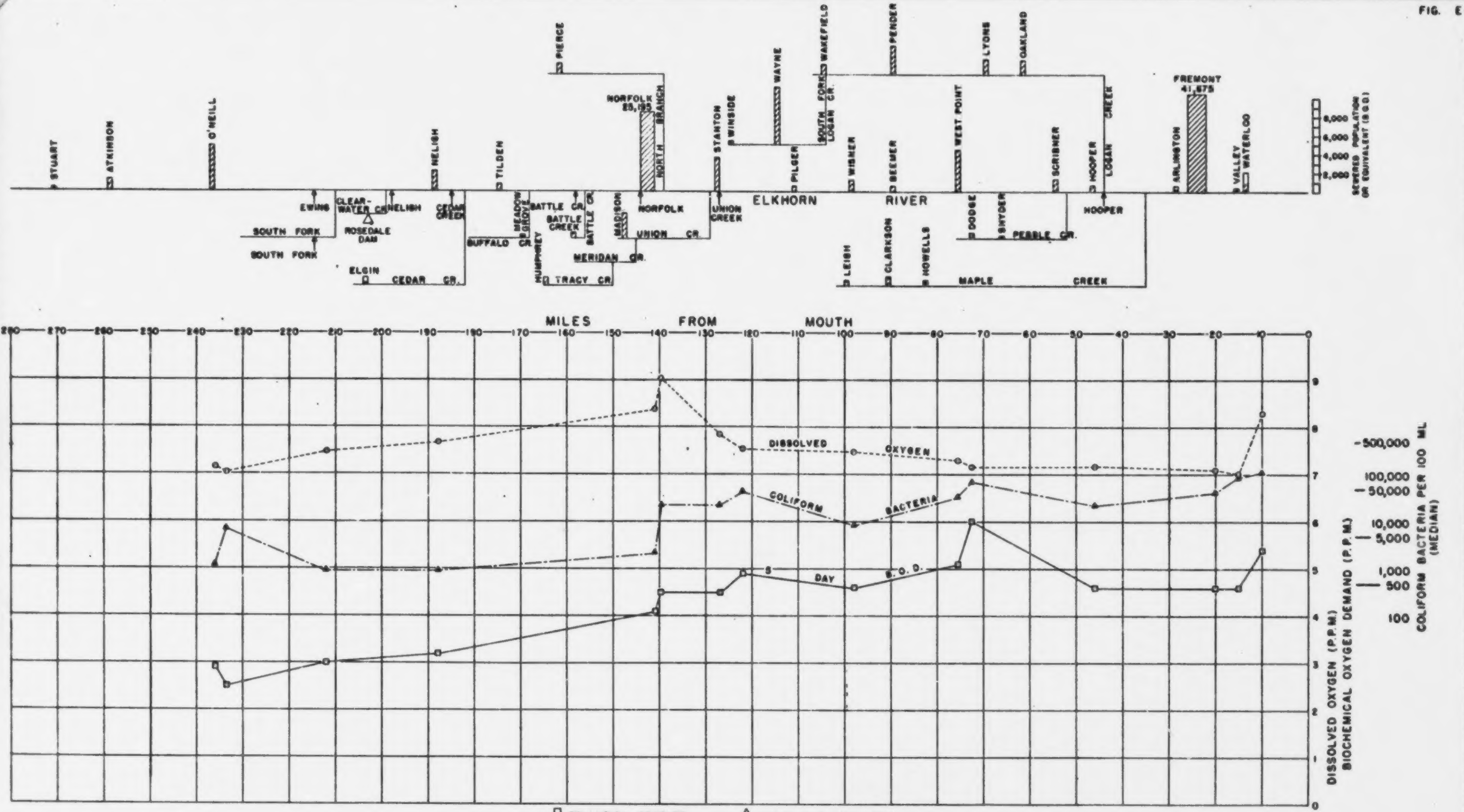
Municipality[1]	Miles above Mouth Elkhorn River	Miles above Mouth Tributary	Industrial Wastes Population Equivalent (B.O.D.)	Population Connected to Sewers	Treatment[2]	Sewered Population Equivalent (B.O.D.) Untreated	Sewered Population Equivalent (B.O.D.) Discharged
Elkhorn River							
Waterloo	13.2		2,160	-	S[3]	2,160	865
Valley	16.1		-	1,000	S	1,000	400
Fremont	22.4		28,075	13,600	N	41,675	41,675
Arlington	27.7		-	600	S	600	240
Maple Creek	34.8						
Howells		46.7	-	600	P	600	450
Clarkson		55.2	-	1,000	P	1,000	750
Leigh		64.0	-	575	P	575	430
Logan Creek	43.8						
Oakland		17.0	215	1,330	N	1,545	1,545
Lyons		24.5	670	1,000	N	1,670	1,670
Pender		44.6	1,680	1,350	N	3,030	3,030
Wakefield		60.0	-	1,150	N	1,150	1,150
S. Fork Logan Creek		60.0					
Wayne		9.6	2,135	4,000	N	6,135	6,135
Winside		19.4	-	400	N	400	400
Hooper	46.2		-	700	N	700	700
Pebble Creek	53.1						
Snyder		13.4	-	325	P	325	245
Dodge		19.8	-	650	ST	650	650
Scribner	55.0		380	910	N	1,290	1,290
West Point	75.5		2,375	2,030	N	4,405	4,405
Beemer	89.0		-	585	N	585	585
Wisner	98.3		-	1,260	N	1,260	1,260
Pilger	110.5		-	550	N	550	550
Stanton	127.2		2,730	930	N	3,660	3,660
Union Creek	128.7						
Meridan Creek		15.8					
Tracy Creek		4.5					
Humphrey		13.8	-	800	ST	800	800
Madison		18.3	935	1,800	ST	2,735	2,735
N. Br. Elkhorn River	141.8						
Pierce		22.4	175	1,010	N	1,185	1,185
Norfolk	143.5		13,495	11,700	N	25,195	25,195
Battle Creek	156.7						
Battle Creek		1.7	-	700	P	700	525
Buffalo Creek	167.7						
Meadow Grove		1.0	-	370	P	370	280
Tilden	174.2		-	850	ST	850	850
Cedar Creek	181.9						
Elgin		20.7	-	800	S	800	200
Neligh	187.7		380	1,750	N	2,130	2,130
O'Neill	236.1		2,325	2,500	N	4,825	4,825
Atkinson	258.0		-	1,200	N	1,200	1,200
Stuart	269.5		-	400	S	400	200
Total			57,730	58,425		116,155	112,210

[1] All municipalities listed are located in the State of Nebraska

[2] Treatment - N - None
P - Primary
S - Secondary
ST - Septic Tank, no effective removal

[3] Treatment of industrial wastes at plant 3/4 mile north of Waterloo

FIG. E-



LOWER PLATTE RIVER BASIN

WATER POLLUTION INVESTIGATION
U.S. PUBLIC HEALTH SERVICE
1950

- ▯ POLLUTION REMOVED BY TREATMENT
- ▨ POLLUTION DISCHARGED

- △ MAJOR DAMS (PROPOSED)
- ▲ MAJOR DAMS EXISTING
- ◣ MINOR DAMS
- † DIVERSION DAMS (PROPOSED)
- † DIVERSION DAMS EXISTING
- ⑤ SEE BASIN DIAGRAM

116-B

ELKHORN RIVER

SOURCES OF POLLUTION
AND
AVERAGE LABORATORY RESULTS
APRIL, MAY, JUNE, JULY / 1949

Low-Flow Frequencies

Low mean monthly flow frequencies were studied for the summer (June-September, inclusive) and winter (December-February, inclusive) periods and are tabulated in table E-7 and E-8 respectively. It will be noted that low flows occur during summer months concurrent with high temperatures which lower the solubility of oxygen in water and increase biological activity. This combination of effects is indicative of the critical period for pollution assimilation when decomposition of organic wastes may result in foul and obnoxious conditions unless sufficient dilution is available to maintain suitable oxygen levels. During low temperature seasons saturated values of dissolved oxygen are higher and stream discharge is greater, which results in an increased normal capacity for waste assimilation. However, water storage during winter may reduce flows significantly. Another winter factor is the natural formation of ice cover over a stream that breaks the contact between the water surface and the atmosphere preventing reaeration, thereby necessitating increased dilution water to preclude development of poor stream conditions. Rather extensive ice cover was observed on the Elkhorn River during winter months.

Laboratory Results

Laboratory data have been plotted in figure E-1 and represent average dissolved oxygen and B.O.D. values and the median coliform count. The dissolved oxygen content of the stream was generally high and reflects field conditions of high spring flows caused by excessive precipitation. A significant depression in dissolved oxygen occurred below the pollution from Norfolk and extended practically to the mouth of the Elkhorn River. This fact is indicative of possible critical conditions in that river reach during warm weather, low flow periods.

The biochemical oxygen demand of the stream was low in the upper reaches of the stream; below Neligh it slightly exceeded three ppm. and showed a gradual increase, as sources of pollution contributed to the stream, reaching a high point of six ppm. near West Point. The accumulation of pollution had its critical effect below West Point, where the B.O.D. was within one part per million of the dissolved oxygen content. Under more normal stream flow conditions it may be expected that the range of B.O.D. would be much greater than that obtained during the present study.

The coliform results, one of the most reliable pollution indicators, were high and ranged from 10,000 to 100,000 M.P.N. in the river reach Norfolk to the mouth.

Nitrates were high below sources of pollution. Very high nitrate values were obtained on South Fork Logan Creek in the vicinity of Wayne. Field investigations showed that this is a livestock grazing area and that manure was being spread for fertilization. It is quite conceivable that surface drainage from this area would contribute much to the nitrate content of the stream. A summary of laboratory data is compiled in appendix G.

Table E-7. Elkhorn River Basin - Frequency of low mean monthly summer (June-Sept.) discharges[1]

Years of Record	Stream and Location[2]	Miles to Mouth		Drainage Area Square Miles	Minimum Monthly Mean Flows in cubic feet per second that may be expected once in:				
		Elkhorn River	Tributary		2 years	3 years	5 years	10 years	Minimum[3]
	Elkhorn River								
15	Waterloo	12.4		6,564	290	220	190	130	87
8	Arlington	27.7			500	330	270	260	260
15[4]	Scribner	55.3			230	130	84	59	17
15[4]	Neligh	187.7		2,200	62	46	36	29	28
15[4]	Ewing	211.8			42	28	20	17	17
15[4]	O'Neill	236.1		651	18	14	10	8	8
	Logan Creek	43.8							
15[4]	Uehling		10.0	1,030	42	30	27	17	12
	North Br. Elkhorn River	141.8							
15[4]	Norfolk		0.7		30	28	24	18	2
	Clearwater Creek	191.5							
15[4]	Clearwater		3.6		15	12	10	8	8
	S.Fork Elkhorn River	210.1							
15[4]	Ewing		1.0		18	16	13	12	12

Table E-8. Elkhorn River Basin - Frequency of low mean monthly winter (Dec. - Feb.) discharges[1]

Years of Record	Stream and Location[2]	Miles to Mouth		Drainage Area Square Miles	Minimum Monthly Mean Flows in cubic feet per second that may be expected once in:				
		Elkhorn River	Tributary		2 years	3 years	5 years	10 years	Minimum[3]
	Elkhorn River								
15	Waterloo	12.4		6,564	330	280	260	230	210
8	Arlington	27.7			450	350	250	140	140
15[4]	Scribner	55.3			220	180	100	96	34
15[4]	Neligh	187.7		2,200	120	100	69	59	30
15[4]	Ewing	211.8			64	62	44	27	17
15[4]	O'Neill	236.1		651	34	33	23	18	8
	Logan Creek	43.8							
15[4]	Uehling		10.0	1,030	47	44	36	28	27
	North Br.Elkhorn River	141.8							
15[4]	Norfolk		0.7		28	24	16	14	12
	Clearwater Creek	199.5							
15[4]	Clearwater		3.6		22	22	17	15	8
	S.Fork Elkhorn River	210.1							
15[4]	Ewing		1.0		27	26	22	20	12

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[1] Based on data obtained from Bureau of Reclamation.

[2] All streams and municipalities listed are located in the State of Nebraska.

[3] Low mean month.

[4] From records and estimates correlated with other flow data.

DISCUSSION

Municipal Water Supplies

Communities secure water from an extensive underground aquifer fed by the great Sand Hills area. The quality of water is generally good although iron and manganese may be found in objectionable quantities and aeration and filtration treatment for their removal is practiced at Norfolk, Arlington, Oakland, and Wakefield. Lyons operates a softening plant in addition to the aeration and filtration facilities.

Irrigation Water Quality

The use of sewage polluted water for irrigation introduces a possible public health problem. Diversion units located a short distance below sources of municipal pollution disperse this pollution to the irrigated areas. Use of contaminated waters on low-growing crops which may be consumed raw constitutes a possible health hazard. The paucity of reliable evidence makes it necessary that these practices be viewed with caution until such time as satisfactory standards have been established for the bacteriological quality of irrigation waters. Chlorination of sewage treatment plant effluents for the control of pathogenic organisms may be indicated.

Sources of Pollution and Status of Sewage Treatment

Pollution contributions along the Elkhorn River occur more frequently and in closer proximity than along other streams of the Lower Platte River Basin. This affects the stream significantly from O'Neill at river mile 236.1 to a point below West Point at river mile 72.0 with an increase in average B.O.D. value from 2.9 ppm. to 6.0 ppm. during the period of study; additional pollution discharged to the Elkhorn tends to maintain this condition to the mouth of the river.

Fremont, Hooper, Scribner, West Point, Beemer, Wisner, Pilger, Stanton, Norfolk, Tilden, Neligh, O'Neill, and Atkinson discharge raw wastes to the Elkhorn River. The City of Fremont is in the Lower Platte Basin but utilizes a long outfall sewer to empty its wastes into the Elkhorn River. The City of Norfolk discharges 90 percent of its present domestic wastes and practically all of its industrial wastes into the Elkhorn while the remaining 10 percent reaches the North Branch Elkhorn River. Treated sewage is discharged to the Elkhorn River by Stuart, Arlington, Valley, and Waterloo.

The principal contributors of wastes to the main stem of the Elkhorn are Norfolk with 25,200 population equivalents and Fremont with 41,700 population equivalents. Fremont has experienced a recent increase in population and industrial growth; a meat packing plant, which will double its present production, may substantially increase the sewered population equivalents discharged to the river.

Logan Creek receives untreated wastes from Oakland, Lyons, Pender, Wakefield, and Wayne. Wayne, on the South Fork Logan Creek, is the largest contributor of pollution with 6,135 population equivalents. Other communities discharging raw sewage to tributary streams are Pierce on the North Fork of the Elkhorn River; Madison on Union Creek; Humphrey on Tracy Creek; and Dodge on Pebble Creek.

Stream Conditions and Sewage Treatment Needs

The degree of sewage treatment required is based on downstream uses and the prevention of health hazards and nuisances during normal low flow. The evaluation of sewage treatment in this section reflects conditions observed during the field investigations and laboratory study and does not consider possible increase in minimum stream discharges which may permit a lower degree of sewage treatment. This subject is discussed in a later section.

On the main stem, Fremont, West Point, Wisner, Stanton, Tilden, Neligh, Pilger, Beemer, and Scribner need a minimum of primary treatment. The analyses of flow data at O'Neill and Norfolk indicate secondary sewage treatment needs unless the development program supplements anticipated low flows. Norfolk has completed engineering studies of its treatment needs.

An industry near Waterloo treats its highly polluting wastes. During the survey it was noted that the treatment plant was in a state of disrepair; suitable improvements should be made notwithstanding the fact contact with the Elkhorn River may be possible only in flood or near-flood stages.

The following sewage treatment needs on tributary streams are indicated: a minimum of primary treatment at Pierce and secondary treatment at Madison, Humphrey, Dodge, Winside, Wayne, Wakefield, Pender, Lyons, and Oakland. Snyder, Leigh, Clarkson, and Howells, which provide primary treatment at the present time, should consider the installation of secondary facilities.

Assuming adequate operation and maintenance, existing facilities are satisfactory at Stuart, Meadow Grove, Battle Creek, Arlington, Valley, the industry at Waterloo, and Elgin. These communities, with the exception of Battle Creek which now utilizes primary treatment, provide secondary treatment of sewage.

Flow Needs: Benefits and Damages

Useful desirable minimum flows are presented in table E-9. These flows have been calculated on the basis of summer stream characteristics, a minimum tolerable level in dissolved oxygen of five ppm., and a minimum of primary treatment of all wastes. Secondary treatment desirable flows are also presented to afford a means

Table E-9. Elkhorn River Basin - Flow needs and cost evaluation

Municipality[5]	Stream	Approximate Miles from Mouth Elk-horn	Approximate Miles from Mouth Tributary	Minimum Normal Flow c.f.s.	Useful Desirable Minimum Flow* c.f.s.	Secondary Treatment Desirable Minimum Flow c.f.s.	Necessary to Prevent Damage to Municipality	Annual Tangible Monetary Benefits Possible if Flow in Column 6 is Provided	Preliminary Estimate Minimum Mean Monthly Flow under Proposed Flow Regulation Program	Annual Tangible Benefits (+) and Damages (-) Under Proposed Flow Regulation Program (Estimated Flow in Column 10)
1	2	3	4	5	6	7	8	9	10	11
O'Neill	Elkhorn R.	236.1		8	20	9	8	$ 5,110	-	$ -
Neligh	Elkhorn R.	187.7		29	7	3	7	0	10	0
Tilden	Elkhorn R.	174.2		30[1]	3	2	3	0	15	0
Battle Creek	Battle Creek	156.7	1.7	-	3	2	3	-	13	-
Norfolk	Elkhorn R.	141.3		40[1]	82	32	40	26,400	10[1]	-18,500
Stanton	Elkhorn R.	127.2		40[1]	20	5	20	0	40	0
Pilger	Elkhorn R.	110.5		45[1]	20	8	20	0	4[1]	- 800
Wisner	Elkhorn R.	98.3		50[1]	20	8	20	0	5[1]	- 1,850
Beemer	Elkhorn R.	89.0		60[1]	-[4]	-	-	-	5[1]	-
West Point	Elkhorn R.	75.5		55[1]	30	11	30	0	6[1]	- 4,900
Scribner	Elkhorn R.	55.0		59	30	11	30	0	6[1]	- 1,900
Hooper	Elkhorn R.	46.2		60[1]	-[4]	-	-	-	6[1]	-
Arlington	Elkhorn R.	27.7		125[1]	2[3]	2	2	0	-	-
Fremont	Elkhorn R.	22.4		130[1]	130	52	130	0	20	-30,800
Valley	Elkhorn R.	15.1		134	-[4]	-	-	0[3]	-	-
Waterloo	Elkhorn R.	13.2		134	-[4]	-	-	0[3]	-	-

*Based on primary treatment

[1] Estimate

[2] Assuming outfall sewer discharges above diversion structure

[3] Secondary treatment plant in operation

[4] Flows influenced primarily by larger upstream sources of pollution

[5] All municipalities listed are located in the State of Nebraska

of estimating the value of additional water made available by secondary sewage treatment.

Where regulated flows increase the normal minimum and thereby allow a city to adequately treat its sewage by primary means instead of resorting to more expensive secondary treatment, a cost benefit may be charged to the project involved. Possible annual tangible monetary pollution control benefits resulting from the lower degree of sewage treatment required and attributable to a flow regulation program are presented in table E-9. Benefits may accrue at O'Neill and Norfolk.

Damages in the form of a higher degree of sewage treatment will result if flow regulation reduces discharges below that required after effective primary sewage treatment or below the normal low expected flow if the latter is less than the desired minimum flow. Treatment over that normally necessary may be required at Norfolk, Pilger, Wisner, West Point, Scribner, and Fremont due to proposed flows under the comprehensive program.

Flow needs during other seasons of the year will vary with water temperature. Minimum monthly mean flows needed as a percent of the summer season flows are given in table 10, General Section. However, when ice cover is complete on the Elkhorn River the minimum desirable winter flow below Norfolk is 45 c.f.s.

Effect of Reservoirs on Pollution Assimilation Capacity of Streams

Reservoir and diversion dam structures have considerable effect upon the pollution assimilation capacity of streams. Ponding of the stream as a result of the construction project substantially changes the normally free-flowing stream into more sluggish bodies of waters equivalent to lakes. Reduction in turbulence would materially reduce atmospheric reaeration which is a major source of oxygen. On the other hand the ponding effect tends to hasten settling and the reduced turbidity favors the penetration of sunlight and encourages the growth of chlorophyllaceous organisms which give off oxygen. Another important consideration is the reaeration caused by the spillway and tailrace of the dam. This may be of particular value during winter conditions when ice cover prevents the absorption of atmospheric oxygen. Where 45 c.f.s. is the desirable minimum flow during winter ice cover conditions in the Elkhorn River below Norfolk, the presence of impounding structures reaerating the stream at various locations below Norfolk would permit this minimum flow to be reduced by approximately 50 percent. In specific instances monetary values could be placed on the reaeration factor of dams.

APPENDICES

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APPENDIX A

MEMORANDUM OF UNDERSTANDING RESPECTING JOINT PROGRAM FOR STREAM POLLUTION INVESTIGATIONS OF THE LOWER PLATTE RIVER BASIN

1. This MEMORANDUM OF UNDERSTANDING, Made and entered into this 29th day of March, 1949, pursuant to the authority contained in the Acts of June 17, 1902 (32 Stat. 388), and acts amendatory thereof or supplementary thereto, known as the Reclamation Laws; the Act of December 22, 1944 (58 Stat. 887), by and between the BUREAU OF RECLAMATION and the PUBLIC HEALTH SERVICE, as party of the second part,

WITNESSETH, THAT:

2. WHEREAS, the Bureau of Reclamation is now engaged in the construction of the Missouri Basin Project, and it has been determined by such agency that it is necessary to conduct a study of stream pollution in the Lower Platte River Basin in order to secure data for use in planning maximum water utilization in such basin as a part of the general plans for the Missouri River Basin Project, and that such study should include, among other things: (a) The extent, types and major sources of pollution; (b) A review of existing laws and pending legislation regarding pollution of public waters in the State of Nebraska; (c) Determine bacteriological quality of water for irrigation uses at present and proposed diversion points and in existing canals; (d) Minimum stream flows necessary below the reservoirs for public water supplies and for sanitation purposes with present and contemplated pollution; (e) Quality of water for municipal requirements and other public uses; (f) Possible benefits to abatement of water pollution problems by reservoir releases; and (g) Recommendations and existing plans for pollution abatement; and

3. WHEREAS, the Bureau of Reclamation does not have the necessary trained and experienced personnel required to perform the pollution survey and study contemplated herein, and does not have all of the necessary equipment required for such a study, and it is necessary therefore to request the Public Health Service to conduct the stream pollution survey of the area drained by the Platte River and its tributaries from Lake McConaughy and Paxton, Nebraska, east to Plattsmouth, Nebraska, hereinafter referred to as the Lower Platte River Basin. The said Public Health Service is willing to conduct such survey on the terms and conditions hereinafter set forth.

NOW, THEREFORE, it is mutually understood and agreed by and between the parties hereto as follows:

4. Beginning on or about April 15, 1949, or as soon thereafter as feasible:

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(a) The Public Health Service will conduct a stream pollution survey of the Lower Platte River and its tributaries, which survey will include, among others, the items set forth in Article 2 hereof. The Public Health Service shall assume full responsibility for the survey and the preparation of complete reports thereon. A final report which will include the findings, conclusions, and recommendations will be submitted as soon as practicable after the completion of field work but not later than July 1, 1950. Fifty copies of the report will be submitted to the Bureau of Reclamation. In addition the Public Health Service will consult with officials of the State of Nebraska relative to pollution problems as involved in the Lower Platte River Basin, and copies of the reports made by the Public Health Service will be furnished to these State officials.

(b) In connection with the survey contemplated herein, the Public Health Service, cooperatively with the Nebraska State Health Department, will furnish, as required, the following services and facilities:

1. Two mobile laboratory units.

2. Professional and subprofessional personnel as necessary for the study

(c) The Bureau of Reclamation will pay not to exceed $3,000 of the actual costs incurred by the Public Health Service in making the stream pollution survey. Transfer of funds will be made monthly to the Public Health Service by the Bureau of Reclamation on the usual Form 1080 upon receipt by the Bureau of statements showing the expenditures hereunder by the Public Service, but such transfers shall not include any work performed hereunder after June 30, 1949.

In addition the Bureau of Reclamation will supply for the use of the Public Health Service in connection with the stream pollution survey such of the following as may be required by the Public Health Service.

1. Limited drafting assistance as can be made available with the regular staff of the field office and as time permits.

2. Maps, charts, hydrologic and other available data.

5. Where the operations of this contract extend beyond the fiscal year 1949 the contract is contingent upon appropriations to the Public Health Service for expenditures hereunder beginning July 1, 1949.

6. No Member of or Delegate to Congress or Resident Commissioner shall be admitted to any share or part of this contract or to any benefit that may arise herefrom, but this restriction shall not be construed to extend to this contract if made with a corporation or company for its general benefit.

IN WITNESS WHEREOF, The parties hereto have caused this memorandum of agreement to be executed as of the day and date first above written.

BUREAU OF RECLAMATION	PUBLIC HEALTH SERVICE
By (Signed) Avery A. Batson	By (Signed) Glen J. Hopkins
Avery A. Batson	Glen J. Hopkins
Regional Director	Officer in Charge
Region 7	Missouri River Basin Office
Denver, Colorado	Kansas City, Missouri

APPENDIX B

STATE WATER POLLUTION CONTROL LEGISLATION

(Outline prepared by Office of the General Counsel, Federal Security Agency, in consultation with the Division of Water Pollution Control of the Public Health Service - February - 1949.)

PRELIMINARY STATEMENT

The greatest State legislative activity in the field of water pollution in the history of this country has occurred in the past decade. About half of the States have passed new laws or amended their old statutes within this period. Since this type of legislation has been concentrated within a relatively recent period, it is not surprising to find a marked similarity in the enactments. In general they have followed the technique of setting up an administrative agency to deal with the problem of water pollution control. Legally, the problem is largely a specialized application of the principles of administrative law.

It is characteristic of State water pollution control legislation to set up a body of statutory and administrative law superimposed on the common law remedies of private parties. The older State legislation was marked by a piecemeal lodging of concurrent water control statutory authority within several departments of the State, such as those dealing with health, agriculture, fish and wildlife, and mines and minerals. The modern tendency is to coordinate all State water pollution control activity under a single administrative agency.

As in most cases where the administrative law approach has been applied, the efficacy of a particular program depends on many extra-legal elements such as administrative personnel, size of appropriation, and public understanding.

The following is an outline of component parts, with suggested criteria, for a State statute for the purpose of establishing and carrying out a program for water pollution prevention and control. This outline will be further developed from time to time on the basis of continued study, consultations and experience.

STATEMENT OF POLICY

A declaration of State policy in the statute is desirable. Such a declaration indicates the basic objectives which are to guide the State agency in the exercise of authority delegated to it by the legislature and is an aid to the administrative agency and the courts in the interpretation of the statute. Such a statement might read:

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> "Whereas the increase in pollution of the waters of this State, due to the growth of population and industrial activities, constitutes a menace to health and welfare, threatens the extinction of fish and aquatic life, and progressively obstructs agricultural, industrial, recreational, and other legitimate uses of water, and whereas the problem of water pollution in this State is closely related to the problem of water pollution in adjoining States, it is hereby declared to be the public policy of this State to conserve the waters of the State for public water supplies, for the propagation of fish and aquatic life, and for agricultural, industrial, recreational and other legitimate uses, to provide a comprehensive program in the public interest for the prevention, abatement, and control of pollution, to provide effective means for the carrying out and enforcement of such program, and to provide for cooperation with agencies of other States and of the Federal Government in carrying out these objectives."

ADMINISTRATIVE AGENCY

1. Administrative authority and responsibility should be vested in a single State agency with comprehensive powers. There should be no exemption of particular municipalities, areas or industries from the jurisdiction of the agency.

   Such a single State agency, charged with comprehensive power and responsibility for carrying out State laws relating to water pollution abatement, would constitute the "State water pollution agency" for purposes of recognition as such under the Federal Water Pollution Control Act. See Sec. 10 (a).

2. The State agency might be:

   (1) a single administrator,

   (2) a commission, with members appointed by the Governor, or

   (3) an ex-officio board, composed of heads of State departments having related responsibilities, such as health, conservation, agriculture, etc., or

(4) variations of the above.

3. Establishment of the agency in the State health department is recommended. If the agency is of the board or commission type the State health officer should be a member.

4. If the agency is to be an ex-officio board, it may be desirable to fix by statute a minimum number of meetings per year.

5. Provision should be made for an executive officer, and there should be authority for the appointment of personnel, including consultants and hearing officers. The merit system should be applicable to personnel of the agency.

6. The agency should be authorized to utilize the personnel and facilities of other State agencies and to make reimbursement therefor.

7. It may be desirable to authorize delegations of authority to subordinate officials, excepting, however, in such matters as the adoption of rules and regulations, comprehensive programs and standards of water purity, the classification of waters, and the issuance of orders or making of any final determination which directly affects the activities or interests of any person or group.

ADVISORY FUNCTIONS

If the agency is of a single-administrator type, a supplementary council with purely advisory functions may be a useful adjunct; such a council may be composed of representatives of other State departments having related responsibilities or (like the Water Pollution Control Advisory Board in the Public Health Service) be expanded to include a limited number of persons (appointed for limited terms) representative of particular fields of expert knowledge, public and private interests. For other types, the value of a statutory advisory council is likely to be less, but the agency should in any case have authority to advise and consult with interested and affected groups. (See "Powers and Duties")

POWERS AND DUTIES

The water pollution agency should have the following powers and duties:

1. To develop a comprehensive program for the prevention, control and abatement of water pollution throughout the entire State;

2. To advise, consult, and cooperate with other agencies of the

State, other States and the Federal Government and with affected groups and industries, in the formulation and carrying out of such a program; to accept and administer loans and grants from the Federal Government and from other sources for carrying out any of its functions;

3. To encourage and conduct studies, investigations, research and demonstrations (with specific mention of industrial waste problems); to collect and disseminate information relating to water pollution and the prevention, control and abatement thereof;

4. To set standards of water purity and classify waters according to their particular uses;

5. To adopt, after hearing, general rules and regulations pertaining to the prevention, abatement and control of water pollution. For example, such rules and regulations might require, among other things, that permits for the operation of treatment works be obtained in certain cases in which they would not otherwise be mandatory under the statute. (See below under "Enforcement" for those cases in which permits should be required by the statute.) They might also establish standards for the operation of disposal systems and treatment works.

6. To issue, after hearing, orders abating discharges or requiring the adoption of such remedial measures, including the construction of new disposal systems or treatment works or the modification, extension or alteration of existing systems and works, as the agency deems necessary or proper; to receive complaints and make investigations in connection with the foregoing;

7. To examine and pass upon all plans and specifications for, and to inspect the construction of (a) new disposal systems and treatment works, (b) extensions, modifications or additions to new or existing disposal systems or treatment works, and (c) extensions and modifications or additions to factories, manufacturing establishments or business enterprises, the operation of which would cause a substantial increase in the pollutional load. (See below under "Enforcement" for suggestion that approval of plans and specifications be required for construction of certain disposal systems and treatment works);

8. To issue, continue in effect, revoke, modify or deny permits, under such conditions as it may prescribe, for the discharge of any wastes, and for the installation and operation of disposal systems and treatment works. (See below under "Enforcement" for suggestion that permits be required for waste discharges);

9. To take all action necessary or appropriate to secure to the State the benefits of the Federal Water Pollution Control Act

(Public Law 845, 80th Congress; 62 Stat. 1155). (See the draft Water Pollution Control Enabling Act for specific functions which would be involved in so doing; it is not suggested that these be spelled out in a comprehensive water pollution control statute except to the extent that legal authorities of the State may consider specification necessary. This draft act was proposed by the Council of State Governments as part of its 1949 legislative program. Copies of the draft act were submitted by the Council directly to the States.)

ENFORCEMENT

It is suggested that the water pollution control law contain enforcement provisions along the following lines:

1. Sanctions against pollution

(a) Prohibit discharge of any wastes from any disposal system or treatment works constructed or operated (i) without a permit from the agency in cases where a permit is required by the statute (see below) or by the rules, regulations or orders of the agency, or (ii) in contravention of the terms of a permit or of the rules, regulations or orders of the agency;

(b) (i) As to new disposal systems and treatment works, plans and specifications should be required to be submitted and approved and permits issued by the agency as prerequisites to their initial construction and operation, as well as to the construction and operation of any extensions, modifications or additions thereto;

(ii) As to existing disposal systems and treatment works, plans and specifications should be required to be submitted and approved and permits issued by the agency as prerequisites to the construction and operation of any extensions, modifications and additions thereto. (See paragraph 5 of "Powers and Duties" above for authority of agency to require, by rule or regulation, that permits be obtained for the continued operation of existing systems or works);

(iii) The submittal of plans and specifications and the issuance of permits should be required for the construction of extensions, modifications, or additions to manufacturing establishments or business enterprises, the operation of which would cause a substantial increase in waste discharges.

(c) Prohibit performance of any act which causes or which may tend to cause pollution in contravention of the standards of water purity adopted by the agency or which is in violation of the rules, regulations or orders of the agency.

(d) Violation of prohibitions in (a), (b), and (c) above punishable by fine, or by fine and/or imprisonment. Statute might also provide for criminal liability of officers and directors of corporation for violations by the corporation.

(e) Each day on which a violation occurs deemed a separate and additional violation.

2. Investigations

The agency should have the power to enter at reasonable times upon any private or public property for the purpose of inspecting and investigating conditions which contribute, or threaten to contribute, to the pollution of any waters.

3. Hearings

(a) The agency should be required to grant a hearing before any rules or regulations of general applicability are adopted which pertain to the prevention, abatement or control of water pollution (e.g., regulations setting standards for the operation of disposal systems and treatment works), or before any order is issued by the agency (e.g., orders prohibiting respondent from discharging wastes), or before any other final determination is made (e.g., revocation, modification, etc., of a permit) which directly affects the activities or interests of any person or group. Provision may be made for summary procedures in emergencies involving hazards of an imminent nature.

(b) The agency should have necessary incidental powers such as the power to compel the attendance of witnesses and the production of testimony, to administer oaths, and examine witnesses.

(c) Safeguards should be provided such as the requirements of (i) seasonal notice, including publication thereof in the event that the proposed proceedings affect a group or groups of individuals, (ii) opportunity of respondents to file answers, and (iii) opportunity of respondents to be represented by counsel at the hearing. (Such safeguards may be spelled out in the statute or provided for by regulations.)

4. Legal action

   (a) The agency should be empowered to bring action to enjoin violation of law or of its rules, regulations or orders.

   (b) The Attorney General of the State may be required to bring civil or criminal action on the request of the agency to enjoin or punish violations.

5. Judicial review

   Judicial review of all final orders of the agency should be provided.

DEFINITIONS

A definition section is an integral part of a comprehensive water pollution control statute. As the purpose of a definition section is to implement the administration and interpretation of the statute, care should be taken to avoid either unduly restrictive or vague definitions.

Terms for which definitions are usually desirable are "sewage", "industrial wastes", "other wastes", "pollution", "sewerage system", "treatment works", "disposal system", "waters of the State", and "persons". While there do not seem to be significant differences among the several States in definitions of the same or similar terms, several caveats are offered:

1. Rigid State-wide definitions of "tolerable pollution" appear to be unsatisfactory as they are either too vague to permit accurate judicial interpretation or too rigid to permit reasonable enforcement. Administrative authority should be delegated to determine the degree of permissible pollution in any given body of water.

2. In the definition of "pollution", the jurisdiction of the State water pollution control agency should be made to extend to those discharges into waters of the State which may create a nuisance or be actually or potentially harmful and detrimental to public health, fish and aquatic life, or recreational, agricultural, industrial or other legitimate uses of water.

3. The definition of the term "person" should not be restrictive but should include the State, any municipality, county, sanitary district, public or private corporation, co-partnership, firm or other entity or individual.

PRESERVATION OF EXISTING RIGHTS AND REMEDIES

A provision should be included to preserve existing legal remedies and safeguards against injuries, actual or threatened, due to water pollution. Such a provision could read:

> "It is the purpose of this Act to provide additional and cumulative remedies to prevent, abate and control the pollution of the waters of the State. Nothing herein contained shall be construed to abridge or alter rights of action of remedies in equity or under the common law or statutory law, criminal or civil, nor shall any provision of this Act, or any act done by virtue thereof, be construed as estopping the State, or any municipality or person, as riparian owners or otherwise, in the exercise of their rights in equity or under the common law or statutory law to suppress nuisances or to abate pollution."

SEVERABILITY

A severability clause should be included to provide that if any part of the statute is declared unconstitutional, the other parts shall not thereby be effected.

CONSTRUCTION AND FINANCING OF SEWERAGE CONSTRUCTION

It is reported that additional legislation is needed in many States to enable municipalities to take full advantage of the loan provisions of the Federal Water Pollution Control Act. The Federal Works Agency has drafted legislation suitable for each of the States where such legislation is desirable to facilitate municipal action for this purpose. Division counsel of the Bureau of Community Facilities of the Federal Works Agency, located in nine field offices of that Agency, are available to discuss such drafts with interested State officials.

APPENDIX C

WASTES FROM POTATO CHIP PLANTS

SUMMARY

A study was made over the operating cycle of a potato chip plant to determine unit production pollution factors. The results of this study were compared to similar process wastes from the preparation of potatoes for dehydration. The present investigation indicates that a population equivalent per thousand pounds potatoes of 66 based on B.O.D., and 120 based on suspended solids would provide tentative unit pollution factors. Similar (1) wastes from the processing of potatoes for dehydration, with the same basic potato characteristics, show a population equivalent of 122 for B.O.D., and 319 for suspended solids. Further studies are indicated.

INTRODUCTION

Numerous small industries encountered frequently during stream pollution surveys may discharge significant amounts of liquid waste. It becomes necessary, therefore, to estimate the pollutional load discharged by these plants based upon investigation of the individual establishment or by applying unit figures secured from detailed study of similar plants.

The manufacture of potato chips is one of these small industries. The meager information regarding wastes from this process made it desirable to conduct studies for the establishment of production unit pollution factors to assist in the evaluation of these plants. It was noted after this study was completed that wastes from the preparation of potatoes for dehydration, as reported by Gray and Ludwig (1), were similar in volume and characteristics and provided comparative data.

METHOD

A study was made over the operating cycle of a potato chip plant. Production was obtained from plant management and waste characteristics determined so that unit factors could be developed.

Laboratory analyses included the following:

1. Biochemical Oxygen Demand (Standard 5-day 20°C.).
2. Suspended solids (total, fixed, and volatile).
3. Settleable solids (1 hour).

All analyses were conducted in accordance with "Standard Methods for the Examination of Water and Sewage", Ninth Edition (1946).

The results of this study were compared to those from similar wastes occurring from the potato dehydration processes.

DESCRIPTION OF PROCESS

Potatoes are received in 100-pound sacks and stored prior to use. They are then peeled, washed, sliced, soaked and finally cooked in oil.

At the plant investigated, the potatoes are fed, on a batch basis, to the potato peeler consisting of revolving carborundum wheels which remove the outer portion of the potato. A constant stream of water discharges to the peeler during its operation. After peeling, the potatoes are washed, inspected, and the eyes and defects removed. They are then conveyed to the slicer. The potatoes are kept wet during handling to prevent discoloration. After slicing, the slivers of potatoes are washed and soaked in a vat to remove starch and surface material which might cause sticking and matting of the chips. The water is removed by a centrifugal dryer and the slices cooked in oil. Following cooling, excess oil is removed by another centrifugal dryer and returned to the cooking vat while the chips are cooled and packaged.

PRODUCTION

The number of employees processing 1,000 pounds of potatoes at two plants, as shown in table I, averaged 3.25.

TABLE I

Plant	Employees per 1000 lbs. potatoes	Potato chips per 1000 lbs. potatoes	Oil used per 1000 lbs. potatoes
A	2.5		150 lbs.
B	4	250 lbs.	125 lbs.

The amount of potato chips produced from 1,000 pounds potatoes was reported as 250 pounds, indicating a shrinkage of 75 percent.

SOURCES OF WASTE

Principal pollutional wastes are from the peeling, washing, and soaking operations.

Receiving and Storage

The potatoes are usually stored in bins prior to processing. Wastes, consisting of decayed potatoes and eyes, may approximate 2.5 percent and are generally disposed of to a dump.

Peeler

Water is fed continuously during the peeling operation, and the volume varies with the amount of potato removed--this is highly variable depending upon the smoothness, depth of the eyes, and the regularity of shape of the potatoes. From about 7 percent to 30 percent or more may be lost in this process; 20 percent being representative of average conditions. The rubbed-off material is discharged with the water as a liquid waste.

Receiving Bin and Washing

After peeling, the potatoes are washed in a bin, inspected, and then conveyed to the slicer. The potatoes are kept wet during these stages of preparation to prevent discoloration.

Washer

Following slicing of the potatoes, the slivers are washed and soaked in a vat to remove starch and other surface material. The vat, equipped with an agitator, has a continuous water feed, with an overflow discharging to a floor drain. The waste from this tank consists primarily of starch and is highly polluting.

Miscellaneous

Oil-spills on the floor around the cooking vat are washed to the floor drain. Wash-up of equipment and floors may also contribute some waste.

Quantity of Waste

The volumes of wastes are shown in table II. During the period of this study, the peeler utilized 234 gallons, and the washing and soakage tank 320 gallons of water per 1,000 pounds of potatoes. This totals 554 gallons per 1,000 pounds of potatoes, although the maximum use was reported as 1,000 gallons--a variation probably caused by the types and shapes of the potatoes processed. Another plant reported 810 gallons per 1,000 pounds of potatoes processed.

TABLE II. Potato chip processing wastes per production unit of 1000 pounds potatoes.

Process	Waste Flow Gallons Per Unit	Analyses					Sewered Population Equivalents per Unit	
		B.O.D. ppm	Settleable Solids Ml. per Liter - 1 Hour	Suspended Solids			B.O.D.	S. S.
				Total ppm	Volatile ppm	Percent Fixed		
Plant A								
Peeler & Wash	234	580	18	1,120	1,004	10.3	6.8	10.9
Washing & Soakage Tank	320	2,025	-	4,068	4,024	1.1		
Total	554[2]						32.4	54.3
Plant B	810						39.2	65.2
Potato Dehydration[1]								
Peeler	300	4,000	185	18,000			60	225
Spray Washing	1,250	1,000	12	1,500			62	94
Total	1,550						122	319

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[1] From Gray and Ludwig "Characteristics and Treatment of Potato Dehydration Wastes" - Sewage Works Journal (Jan. 1943)

[2] Maximum reported flow 1000# - plant

CHARACTER OF WASTES

The analyses of wastes from the peeler and soakage tank are also shown in table II. It is of interest to note the small percentage of fixed suspended solids indicating the high organic content of the starch waste. The strength of the waste is several times that of domestic sewage.

DISCUSSION

The characteristics of the type of potato being processed will affect the quantity and quality of waste produced. The solids content of potatoes may vary from about 15 to 30 percent; the Idaho type has the highest content, the Rocky Mountain varieties the lowest, and the eastern kind are intermediate (1). Other factors also influence the solids composition such as seasonal variation, storage, and method of growing. At the time of this study, California White Shafter potatoes from the new crop were used and the manager mentioned that with older potatoes the amount of peelings removed might double to obtain a smooth clean product suitable for slicing.

A more useful figure for evaluating the amount of pollution discharged may be that based upon the pounds of dry potato solids lost in the peeler. Such information founded on a peeler loss of 20 percent and potato solids concentration of 25 percent was presented by Gray and Ludwig (1) and is included on table III. Present survey data were calculated on the basis of 7 percent loss in the peeler and potato solids concentration of 15 percent (table III). The pounds B.O.D. in the waste per pound of dry potato solids wasted was 0.11 as compared to 0.20 from similar waste in the potato dehydration process. Similarly, the pounds of suspended solids discharged per pound of dry solids that were wasted was 0.22 pounds as compared with 0.9 pounds from the dehydration wastes. Since the suspended solids and settleable solids of the peeler waste from the preparation of potatoes for dehydration ran much higher than in potato chip preparation wastes, it appears that the potato received rougher treatment in the former process, thereby causing the potato solids to be larger and measured as settleable and suspended solids. The correlation on the basis of B.O.D. between the two results is within reason, considering the wide variation in the types of potatoes and methods of processing.

The volume of wastes from the washing and soaking of potatoes after slicing varied considerably in the two studies. However, in the present investigations, the potatoes were washed in a soakage vat with a small constant overflow during a portion of the operating period, and the volume was low. The strength of the waste would probably vary with solids concentration of the potatoes, but would be difficult to evaluate closely because of different thickness of the slice, degree of

TABLE III. Waste evaluation

Per Ton	Peeler Waste 7% Loss 15% Potato Solids	 20% Loss[1] 25% Potato Solids	Soakage Tank Wastes	Spray Washing Wastes[1]
Gallons	468	600	640	2,500
B.O.D. - ppm	580	4,000	2,025	1,000
Lbs/Ton	2.264	20	10.8	20
Lbs/Ton/% Loss	0.32	1.0		
Lbs/Lb. Dry Potato Solids lost	0.11	0.20		
Suspended Solids	1,120	18,000	4,068	1,500
Lbs/Ton	4.37	90	21.7	30
Lbs/Ton/% Loss	0.63	4.5		
Lbs/Lb. Dry Potato Solids lost	0.22	0.90		

[1] From Gray and Ludwig "Characteristics and Treatment of Potato Dehydration Wastes" - Sewage Works Journal (Jan. 1943)

wash and length of soak. The pounds B.O.D. per ton of wastes from the washing process were 10.8 as compared to 20 from the process preparing potatoes for dehydration. Likewise, the pounds of suspended solids per ton of potatoes processed were 21.7 for this study and 30 for the dehydration wastes.

POPULATION EQUIVALENTS

The data presented will provide means of estimating tentative unit pollutional factors for the processing of potatoes for potato chips. The population equivalents are based on a per capita discharge per day of 0.167 pounds 5-day 20°C. B.O.D. and 0.20 pounds suspended solids.

For normal operations, the waste from the peeler may be estimated to include 20 percent of the potatoes having 25 percent solids concentration. Utilizing these figures (table III), the population equivalent of peeler wastes from the processing of 1000# potatoes during this study will be 33 based on B.O.D. and 66 on suspended solids as compared to 60 and 225 respectively for potato dehydration wastes. Wash and soakage wastes showed 32 population equivalents based on B.O.D. and 54 on suspended solids as compared to 62 and 94 respectively for similar wastes from the dehydration process. Additional studies for the evaluation of potato processing wastes are indicated.

The following appear to be reasonable tentative estimates for appraising potato chip processing wastes:

	Population Equivalents per 1000 lbs. Potatoes	
Type of Process	B.O.D.	Suspended Solids
Potato Peeling	33	66
Soakage and Wash	32	54
Total	65	110

ACKNOWLEDGMENT

This study was conducted as part of a water pollution investigation of the Lower Platte River Basin developed under a cooperative agreement among the Nebraska State Department of Health, Bureau of Reclamation, and Public Health Service.

Special acknowledgment is made to the field staff conducting these studies particularly Chemists W. W. Walker and C. N. Shadix.

Analyses were made by the Public Health Service field laboratory. In all instances, cooperation by industry was excellent.

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APPENDIX D

PARTIAL REVIEW OF LITERATURE ON PUPLIC HEALTH ASPECTS OF IRRIGATION WITH SEWAGE POLLUTED WATER[1]

1. Davidson (1), according to Wilson (9), reports an outbreak of typhoid and paratyphoid fever involving 65 cases in North Battleford, Saskatchewan, Canada, during the summer of 1941. Neither milk nor water could be incriminated as the agent of transmission. Inconclusive evidence indicated that the infection was spread by vegetables which were irrigated, and possibly washed, with water from a ditch into which the sewage works discharged its effluent.

2. Chapman (2), stresses the need for treatment of sewage discharged to streams from which water is taken to irrigate market produce. Investigations conducted by the Colorado State Board of Health have shown that vegetables, grown in fields many miles below the source of the pollution, contained large numbers of colon bacilli. In many instances washing could not make them fit for human consumption. Some epidemiological evidence is presented. The death rate for typhoid fever, also for diarrhea and enteritis in infants up to 2 years of age, in Colorado is high when compared to that for the U. S. and several western states. Colorado counties having polluted waters have death rates for the above infections almost twice those of counties in which there is little or no pollution of streams. Maps are presented which show the grossly polluted streams are closely associated with the counties having these higher death rates. Water and milk were not considered the infection source. It was recommended that fruits and vegetables grown under or close to the ground should not be irrigated with sewage polluted water. Although cooking may make eating such vegetables safe, it does not eliminate the possibility of introduction of infectious matter into the kitchen and its transfer to foodstuffs.

3. Lumsden and Anderson (3), in their investigation of the origin and prevalence of typhoid fever in the District of Columbia, found (3a) "a suggestively large portion of the typhoid cases in the District of Columbia had eaten lettuce, celery or strawberries during the 30 days prior to illness." They experienced difficulty in tracing the produce back to its source and therefore considered definite conclusions "not justifiable". They conclude (3b), however, that "In view of the insanitary conditions, particularly in respect to the lack of sanitary privies on farms which supply a large portion of the green vegetables and fruits distributed in Washington, it seems quite probable that those foodstuffs play some part, and for occasional

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[1] Acknowledgment is made of the use of this Review as included in the South Platte River Basin Interim Report and the Kansas River Basin Water Pollution Investigation.

periods perhaps a very considerable part, in the distribution of typhoid-fever infection in the District of Columbia". Furthermore, they recommend (3c), "The enactment of legislation prohibiting the sale or the offering for sale in the District of Columbia of . . . any green garden truck obtained from farms not provided with either sanitary privies or sanitary water-closets".

4. Bundsen (4), reports that following a typhoid outbreak in Chicago, which was eventually traced to oyster infection, special effort was made to determine the sources of certain vegetables, lettuce and watercress, served in hotels and restaurants, where it appeared the majority of cases had contracted the infection. This was found to be impossible; there was no common source for such produce. In connection with the investigation bacteriological examination of fruits, vegetables and watercress was undertaken. E.coli bacteria were found but whether of human or other source was not determined. In one case high coli contamination of lettuce was traced to the ice in which it was packed. Need for greater attention to watercress is stressed. In the discussion of Bundsen's paper Dr. F. C. Johnson, a pediatrician, comments that based on his experience he has "advised not to feed lettuce or celery to children as the possibility of infections being carried by these raw vegetables is really great."

5. In the discussion (5) of Dr. Warrys report of an outbreak of enteric disease involving 110 cases in the borough of Hackney, England, it is noted that a high percent of the cases had partaken of watercress within 3 weeks prior to the illness, and bacteriological examination of beds from which the watercress had been taken showed the presence of sewage organisms, in one case, as high as 50 E. coli bacteria per cubic centimeter of water.

6. An article in the Journal American Medical Association (6) notes the raising of vegetables, frequently eaten raw, on the Paris, France sewage farm and associates the occurrence every year, from July to October, of typhoid fever in Paris with the marketing of these vegetables. "Clauditz found germs, after several days, on green herbs thus treated which a thorough washing could not remove. Dr. E. Marchoux, after an investigation, 'recommended that the kinds of herbs and vegetables that may be grown on sewaged land be established by law.'"

7. The American Society of Civil Engineers' committee on salvage of sewage (7) notes that in 1934 the directors of public health in each of the 48 states and the District of Columbia were asked for information on the extent of sewage use for irrigation. Only 9 states, of the 40 replies received, admitted having experience with sewage irrigation and sewage irrigated crops. Significantly, "four were able to trace illness of an epidemic order to such use, whereas one other stated that cattle, pastured on a raw sewage irrigated field developed poorly and were infested with *Cysticercus bovis*". At that time (7a)

"Only one of the nine was agreeable to the use of (sewage) treatment plant effluent on vegetables to be eaten raw", and that state prescribed practically potable water standards for such effluent. In summarizing the committee states (7b) "Thus it would appear that, except for use upon vegetables to be eaten raw, an effluent from about that afforded by subsidence, trickling filters, and secondary subsidence effecting about 85% reduction in biochemical oxygen demand (B.O.D.) and suspended solids, followed by chlorination, should satisfy health requirements..."

8. Roberts (8) noted 23 of 45 cattle fattened on the Tucson, Arizona, sewage farm were upon slaughtering found infested with the tapeworm, *Cysticercus bovis*. Since these cattle apparently came from different sources -- they all bore different brands - and such general infestation indicated a source common to all or most of them, it was concluded that the infestation resulted from drinking sewage polluted water.

9. Wilson (9) cites the experience at the Melborne, Australia, sewage farm where in 1937, 46% of the cattle grazed were found infested with *Taenia saginata*. The sale of these cattle was banned. During a six month survey of Melborne (1941-42) 100 cases of human tapeworm infections were treated. He concludes, "In ... any town where large portions of the inhabitants are infested with tapeworm ... sewage and sewage sludge must present a real danger."

10. Under Annotations (10) it is noted that Leptospirosis is essentially an occupational disease. Human infection is acquired through the alimentary tract or by contact with contaminated water or other material. It has occurred "during the last few years among ... sewer workers in London and Glasgow ..., and workers in the beet fields in Ireland, who are probably infected through abrasions of the hands in the same way as are the sugar cane cutters in Queensland".

11. Mills et al. (11) conducted laboratory investigations to determine whether the bacteria penetrated the surface of fruits and vegetables. They found that although bacteria do not penetrate the uninjured surface, they may gain entrance through damaged or decayed surfaces and remain viable for from 7 to 42 days. They also demonstrated that bacteria may persist on the surface of fruits or vegetables kept moist for 15 or more days.

12. Fligler (12) investigated the survival and dispersion of typhoid and dysentery bacilli in soil. These bacteria were recoverable from artificially inoculated moist soil (pH 6.6-7.4) for 70 or more days, but were not recoverable in dry soil on the 20th day. They penetrated to a depth of 2, but not 3, feet in 40 days in relatively porous soil under a 1 to 2 inch head of water.

13. Melick (13) in three outdoor experiments, extending from May to September, isolated typhoid bacteria from garden soil 41, 34 and 35 days after inoculation with typhoid bearing excreta. Under hot house conditions old strains of typhoid bacteria survived for 74 days in garden soil enriched with sterile sewage; fresh strains survived only 49 days. In these experiments typhoid bacteria were found on radishes grown in infected soil 37, 28 and 35 days, and on lettuce after 21 days, after inoculation of the soil. The organism became attached to the surface and was not ordinarily removable by washing.

14. Creel (14) investigated the viability of typhoid bacilli on garden truck. He reports 3 experiments in which radishes and lettuce were raised on soil sprinkled with a fecal emulsion mixed with 24-hour old culture of typhoid bacilli 2 or 3 days after the planting.

He states, "that plants cultivated in contaminated soil will take up on the leaves and stems, as they grow through the soils, organisms existing therein."

"The Bacillus typhosus (typhoid bacillus) was recoverable from the tips of leaves that were, to the naked eye, free from soil" and that when these vegetables were grown under natural conditions (except for the artificial inoculation of the soil) the infectious material could be isolated from the leaves up to 31 days.

"Rainfall will not free the vegetables from the infected material".

15. According to Melick (13) "Morse (15) attributed 49 typhoid cases among inmates of an insane asylum to the eating of celery." Typhoid cases had occurred in the institution a few months previously, the celery bed received the institutions sewage, and the epidemic occurred soon after the first use of the celery.

16. According to Melick (13) "Picley (16) records 2 cases of typhoid from eating uncooked rhubarb, which was grown on soil known to be fertilized with typhoid bearing excreta."

17. Veatch (17a) in discussing the Denver, Colorado sewage disposal problem notes that on certain days the Denver sewage accounts for 97% of the flow of the South Platte River, which is used for irrigation immediately downstream. He refers to the construction at Denver in 1937 of a sewage treatment plant which included "fine grained rapid sand filters to secure a high rate of removal of suspended solids and incidentally the removal of ... the encysted type of amoeba (Endamoeba histolytica) which is strongly suspected of being responsible, through the medium of sewage irrigated vegetables, for a considerable amount of sickness in this area." (Abstractor's note: The magnetite filters referred to did not operate satisfactorily and their use was discontinued.)

18. Tanner (18) points out that missed cases and carriers may always be present and that sewage should always be regarded as containing infectious organisms. The work of several investigators is cited and Tanner concludes that (18a) "Sufficient data ... have been recorded to justify the conclusion that polluted soil may infect vegetables grown on it." He adds (18b) that "good epidemiological evidence seems to exist in the literature to the effect that fresh vegetables may and have caused communicable diseases and that the sanitary condition of the soil from which they are harvested is important." - and finally (18c) that "This review of the literature quite clearly indicates that fresh vegetables which are raised on polluted soil may transmit pathogenic bacteria."

19. Rider (19) in commenting on irrigation in Arizona notes the insanitary practices of many camps of agricultural workers and the use of the main canals for drinking water, swimming, washing clothes, etc. In spite of such conditions only a few instances were noted where water borne diseases were attributed to canal water. Several years ago, as the result of a newspaper syndicated article, the state laboratory undertook bacteriological examination of lettuce. Many heads -- from 16 fields in the Salt River Valley and from two in the Eloy district -- were cultured but no evidence of typhoid or allied organisms was found. Although the technique used was rather hastily devised, it was felt any general contamination would have been indicated.

20. The Committee on Sewage Disposal, American Public Health Association (20) notes in 1937, that "California, alone, out of 33 states reporting, ... has adopted regulations under its Public Health Act whereby the disposal of sewage, sewage effluent or sludge for irrigation or fertilizing purposes" requires a permit from the State Board of Health. Briefly these California Regulations require that raw sewage shall not be used for irrigating growing crops, and settled or undisinfected sewage is banned for the irrigation of growing vegetables, garden truck, berries, or low-growing fruit, or for watering vineyards or orchards where windfalls or fruit lie on the ground.

21. The Committee on Utilization of Sewage Sludge as Fertilizer, Federation of Sewage Works Associations, in their report (21) in 1942, notes the California regulations are still in effect. Several other states regulate or advise regarding use of sewage sludge.

22. Rawn (22) notes that as of June, 1934, 39 states and the District of Columbia had replied to a questionnaire on use of sewage for irrigation. Thirty states reported neither sewage nor sewage-polluted waters were used for irrigation within their boundaries. Seventeen of these states reported they would not tolerate such use, and the other 13 found it repugnant.

"In the 9 states which admitted use of sewage for irrigation, the attitude was one of tolerance ... and rigid regulations of the production of the effluent as well as the nature of the crops for which it was to be used."

23. DeMartini (23) mentions the following regulations concerning irrigation with sewage and sewage-laden waters:

> (1) Colorado - "Requires written permission of State Board of Health for use of sewage or sewage-polluted waters when Coli-aerogenes group of bacteria exceeds 10 per cc."
>
> (2) California and Oregon - "Prohibit use of raw sewage for irrigating growing crops. Prohibit use of settled or undisinfected sewage effluents on growing vegetables and garden truck. Highly oxidized and disinfected sewage effluents can be used provided they meet drinking water standards in Oregon and in California if not over 10% of 10cc. portions are positive for the Coli-aerogenes group. Also no single sample can be positive for over half of the 0.1 cc. portions examined."

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APPENDIX E

NITRITES AND NITRATES IN WATER SUPPLIES

GENERAL

The decomposition of organic material resulting from bacterial action forms a number of nitrogen compounds, including the mineral nitrate salts. The amount of nitrates found in water serves to indicate the progress toward complete oxidation and stability. In areas where nitrate fertilizer is used nitrate may be washed from the soil and may appear in both shallow and deep waters over a considerable area. Wells near fields of alfalfa or other legumes might receive some of the nitrate which these plants have added to the soil (7). Recent investigations have focused attention to the finding of nitrate in water supplies because of its relationship to infant cyanosis.

Turneaure and Russell state (1):

> "Because of the occurrence of deposits of nitrate nitrogen in certain areas of the earth's surface, and because of the constant presence in most soils to the extent of 5 to 100 ppm., the mere presence of small amounts (up to probably 5 ppm) of nitrogen in well and spring water should not be considered sufficient reason for the condemnation of the supply, especially if the bacteriological evidence is negative. Since nitrate nitrogen occurs in oxidized sewage effluents in amounts as high as 20 ppm. and higher in soil leachings from around manure piles and privies, it seems reasonable to consider the presence of nitrate nitrogen above 5 ppm. as indicative of dangerous pollution."

Until recently mineral nitrates have been considered harmless and in the same light as the chloride content of water supplies.

Infant Cyanosis

Infant cyanosis was generally accepted as being due to congenital heart defect, thus nitrate poisoning, the cause of infant cyanosis, was overlooked because symptoms resembled those of babies afflicted with heart defects. The medical explanation of nitrate poisoning dates back to 1928. At that time it was known that nitrate reduced to nitrite in the body would combine with the red oxygen-carrying hemoglobin, or blood pigment, to produce methemoglobin, a brownish colored compound. The skin would then attain a greyish-blue color.

Observations of an Iowa physician in 1945(2), with respect to the relationship between cyanosis of infants and nitrates in water. led to the suggestion of an upper nitrate limit of 10 ppm. in Iowa water supplies. In Minnesota (6) data compiled by the State Department of Health bear out the fact that waters containing 10-20 ppm. of nitrate affected infants two months old and younger by methemoglobinemia. The linking of nitrates and infant cyanosis in infants aged six months or under, and the nonsusceptibility of older children and adults, led to additional investigations. The numerous cases in Iowa have opened the field to a more definite recognition of the cause and effect of infant cyanosis.

Thirteen cases in Nebraska (4) have been accepted as being due to the ingestion of nitrate in the formula concocted using well water. There is a possibility that a more complete epidemiology would add to this total. It is important to note that data in the examination of the 13 cases included analysis of the water; the range of nitrate nitrogen was 36 - 200 ppm.

In Missouri, in 1948, experiments conducted upon two groups of infants brought out the fact that infants with gastric acidities of pH 4.0 or above, and nitrate-reducing bacteria in the upper intestinal tract, developed infant cyanosis upon drinking water containing nitrates. Infants possessing a gastric acidity with pH less than 4.0 did not develop cyanosis despite the fact they were fed water of high nitrate content. Nitrate when introduced into the colon, which always contains nitrate-reducing bacteria, irrespective of the gastric pH, caused cyanosis. This experiment showed the nitrate-reducing bacteria do not find favorable conditions in an acid environment; the nitrite was not formed and therefore could not combine with the hemoglobin to form methemoglobin with the resulting skin discoloration.

Occurrence of Nitrates

Fair (3) mentions that nitrates in surface waters come largely from the soil where there is constant mineralization of nitrogenous organic matter. The nitrate content of water, which has undergone heavy pollution with soil washings or human wastes far upstream, may be several parts per million.

Large amounts of nitrates, varying from 1.0 to several ppm, may be found in shallow ground waters which receive local pollution. Another cause for the high nitrate content may be due to the oxidation of soil nitrogen. The former is an element of considerable sanitation importance in addition to its position in the infant cyanosis picture.

Other pollution factors remain to be established in the determination of high nitrate contents of deep well waters in locations where the source of contamination has not been determined.

The Nebraska State Health Laboratory has an established organization for testing water samples. When examinations of private wells disclose 10 or more ppm. nitrate, the user is notified and cautioned as to the unfitness of the well water for feeding an infant 6 months of age or less. Where water containing 10 ppm. or less of nitrates is boiled evaporation will concentrate the nitrate thus enhancing the probability of cyanosis. The same measures apply to cases in which public water supplies are found to possess high nitrate concentrations.

Public health significance

The public health significance of methemoglobinemia has increased and is reflected in recent investigations. In a survey of Nebraska wells 900 private and over 300 public supplies were tested. One hundred and ninety wells, including 16 municipal supplies, were found high in nitrates. Most of these were in the Glacial ground water area, which includes Knox, Lancaster, and Pawnee Counties. The Nebraska plains and Perkins Table areas had several wells with high nitrate content; the Platte Valley, where irrigation and fertilization methods are followed, showed little.

The survey also showed the average well with high nitrate content to be 48 feet deep; municipal wells deeper than 90 feet had less than 10 ppm. of nitrates; private wells deeper than 200 feet were in the same category.

A further breakdown demonstrated bacterial contamination. Forty percent of the high nitrate wells had E. Coli, the organism present in intestinal discharges, and 28 percent contained A. aerogenes, a soil micro-organism. Twenty percent of low nitrate wells showed a similar bacterial contamination.

A study of the construction of wells was included in the survey. Dug wells accounted for 45 percent of the high nitrates in private wells.

SUMMARY

Nitrates in waters have been found to cause methemoglobinemia in infants aged 6 months and less. Older children and adults are not affected.

The epidemiology of infant cyanosis indicates a greater incidence of the nitrate poisoning than that indicated by reported cases.

Although no direct relationship has been found between bacterial contamination and high nitrate content of water supplies, and satisfactory reports of water examinations do not indicate such waters to be free of high and possible harmful high nitrate concentrations, a greater percentage of wells with high nitrates will show bacterial contamination than wells with low nitrate values.

A maximum figure of 10 ppm. (5) has been suggested as the upper limit of nitrates in well waters to be used in infant feeding. Boiling waters containing low nitrate content will result in a higher nitrate concentration thus rendering the water nocuous.

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APPENDIX F

SAMPLING STATION DESIGNATIONS

A system of river miles and stream abbreviations were used to facilitate field designation, to simplify reporting, and to aid in tabulation of data (appendix G). Each sampling station located on a river or creek was identified by the stream's initial or abbreviation and the distance in river miles from the mouth of the stream; for example, Station P.-115.0 is a point on the Platte River, 115.0 miles from its mouth; E-46.2 is on the Elkhorn River, 46.2 miles from its mouth; and Un.C.-18.3 is 18.3 miles from the mouth of Union Creek. Similar names in different sub-basins were indicated by different abbreviations as P.C. (Plum Creek) and Pl.C. (Plum Creek). Where a sampling station was located on a tributary, the river miles from the mouth of the main stream to the tributary was recorded as was the river miles from the tributary's mouth to the sampling station; for example, the sampling station listed as E-43.8, Lo.C.-60.0, S.F.Lo.C. -9.6 would indicate that Logan Creek is located 43.8 miles from the mouth of the Elkhorn River; South Fork Logan Creek 60.0 miles from the mouth of Logan Creek; and then 9.6 miles up South Fork Logan Creek to the sampling station in question.

Where multiple sampling at a given point was necessary, due to stream channels or other conditions, sampling point designations were given postscripts as "L" for the left side, "C" for the center, or "R" for the right side, facing downstream.

Sampling station locations, using directions and distances from towns, numbered or unnumbered highways, or other easily identified reference points were also used (appendix G).

Stream designations used in this survey are listed below; tributaries are indented.

- P. - Platte River
  - Sa. C. - Salt Creek
    - Wa. C. - Wahoo Creek
  - Sh. Cr. - Shell Creek
  - Lt. C. - Lost Creek
  - W. R. - Wood River
  - T. Cr. - Turkey Creek
    - K. Can. - Kearney Canal
  - P. C. - Plum Creek
  - S. P. - South Platte River
  - N. P. - North Platte River

E. - Elkhorn River
Lo. C. - Logan Creek
S.F. Lo. C. - South Fork Logan Creek
Dr. Cr. - Deer Creek
Un. C. - Union Creek
N.B.E. - North Branch Elkhorn River
Cl. C. - Clearwater Creek
S.F.E. - South Fork Elkhorn River

L. - Loup River
Be. C. - Beaver Creek
Ce. R. - Cedar River
Sp. Cr. - Spring Creek
N. L. - North Loup River
Da. C. - Davis Creek
Ca. R. - Calamus River
M. L. - Middle Loup River
S. L. - South Loup River
Mu. C. - Mud Creek
Di. R. - Dismal River

APPENDIX G

SUMMARY OF INDIVIDUAL RESULTS

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LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO$_4$
					p.p.m.	% Sat.							NH$_3$	NO$_2$	NO$_3$	
Salt Creek Bridge - Highway #6 1 1/2 miles east and 4 1/2 miles north of Ashland	P - 26.4 Sa.C. - 0.7	11:32 A Apr. 28	185	16	8.83	88.7	3.5	15,000	8.5	45	293	1,070	0.170	0.120	0.500	-
	"	9:33 A May 3	153	16	7.60	76.4	5.6	910	8.3	25	290	2,260	0.080	0.070	0.300	-
	"	8:52 A May 9	3,690	15	3.26	32.1	22.3	460,000	7.4	9,700	104	284	0.650	0.050	0.500	-
	"	10:15 A May 16	245	19	5.62	60.1	12.5	93,000	8.2	5,100	292	950	0.430	0.110	1.250	-
	"	10:44 A May 23	1,470	18	6.21	65.1	4.0	930,000	7.5	11,000	113	72	0.420	0.042	1.800	-
	"	10:32 A May 26	366	18	6.81	71.4	2.5	43,000	7.9	600	209	340	0.270	0.001	2.000	-
	"	10:14 A May 31	313	19	6.20	66.3	2.6	93,000	8.2	450	250	680	0.290	0.130	0.450	-
	"	12:27 P June 6	350	22	6.45	72.9	2.6	150,000	7.7	500	200	560	0.450	0.150	0.750	-
	"	8:20 A June 13	7,260	21	3.23	35.9	2.4	1,100,000	6.8	20,500	68	123	0.480	0.023	-	-
	"	6:16 A June 20	986	20	4.83	52.7	3.4	230,000	7.5	10,200	96	90	0.350	0.003	0.050	-
	"	11:51 A June 27	379	22	5.81	65.8	5.4	430,000	7.7	2,200	160	464	0.270	0.009	0.160	-
Wahoo Creek Bridge - 2 miles south and 2 1/2 miles east of Wahoo	P - 26.4 Sa.C. - 2.8 Wa.C.-21.2	7:40 A Apr. 28	-	14	7.01	67.6	2.4	24,000	7.9	40	291	32	0.260	0.013	0.300	-
	"	5:55 A May 3	-	17	7.43	76.3	3.0	15,000	7.9	55	275	54	0.230	0.022	0.700	-
	"	5:43 A May 9	-	15	7.69	75.7	6.6	460,000	7.9	285	241	47	0.420	0.095	1.400	-
	"	6:09 A May 26	-	17	7.01	72.0	3.8	230,000	7.9	500	299	37	0.395	0.002	2.050	-
	"	6:21 A May 31	-	19	6.28	67.2	3.3	230,000	8.1	400	277	40	0.340	0.080	0.700	-
	"	7:05 A June 6	-	16	7.10	71.3	>7.1	4,300	7.7	240	286	22	0.355	0.052	2.100	-
	"	10:36 A June20	-	22	5.59	63.2	8.2	240,000	8.3	2,900	167	14	0.650	0.035	1.000	-
	"	7:16 A June 27	-	22	3.55	40.2	2.9	20,000	7.0	13,000	116	4.5	0.650	<0.001	0.110	-
Wahoo Creek Bridge - southwest of Wahoo at confluence of Cotton Creek	P - 26.4 Sa.C. - 2.8 Wa.C. -25.2	1:22 P Apr. 25	-	20	11.34	123.9	4.5	4,300	8.6	35	174	25	0.500	0.012	0.400	-
	"	6:50 A Apr. 28	-	14	7.78	75.1	1.5	430	8.3	50	288	25	0.060	0.010	0.400	-
	"	5:24 A May 3	-	16	7.27	73.1	2.3	930	8.1	30	301	26	0.060	0.015	0.600	-
	"	5:14 A May 9	-	14	7.65	73.8	7.0	>110,000	7.8	800	257	18	0.320	0.035	1.700	-
	"	7:30 A May 16	-	19	6.70	71.6	2.7	43,000	8.3	390	283	18	0.230	0.038	1.200	-
	"	7:52 A May 23	-	16	7.60	76.4	5.2	23,000	7.7	3,000	180	14	0.440	0.045	2.500	-
	"	5:38 A May 26	-	17	7.48	76.8	2.4	43,000	8.3	500	281	15	0.310	0.002	2.150	-
	"	5:49 A May 31	-	20	7.11	77.4	2.4	9,300	8.1	300	308	17	0.250	0.045	1.150	-
	"	6:29 A June 6	-	16	6.51	65.5	2.4	4,300	7.7	250	292	23	0.395	0.024	-	-
	"	5:03 A June 13	-	23	5.61	64.6	2.8	9,300	8.3	340	307	26	0.185	0.084	-	-
	"	11:02 A June 20	-	21	5.50	61.2	8.4	46,000	8.1	3,000	172	18	0.655	0.038	0.650	-
	"	6:22 A June 27	-	20	3.20	34.9	12.9	93,000	7.1	13,000	109	9.5	-	-	-	-
Salt Creek County Bridge - 1/2 mile south of Ashland	P - 26.4 Sa.C. - 3.8	11:08 A Apr. 28	-	15	11.66	114.8	4.3	9,300	8.7	30	318	1,400	0.170	0.130	0.080	-
	"	9:06 A May 3	-	16	8.36	84.0	3.6	4,300	8.4	30	324	2,490	0.160	0.040	0.180	-
	"	8:18 A May 9	-	15	2.82	27.8	21.6	1,100,000	7.3	9,600	101	277	0.650	0.045	0.600	-
	"	10:02 A May 16	-	19	7.11	76.1	4.3	93,000	8.4	200	305	1,240	0.380	0.130	0.750	-
	"	10:20 A May 23	-	17	6.36	65.4	4.4	230,000	7.5	10,500	117	123	0.420	0.050	1.900	-
	"	10:18 A May 26	-	18	7.29	76.4	6.5	230,000	7.7	800	223	540	0.270	0.001	1.950	-
	"	9:54 A May 31	-	18	6.29	65.9	2.6	93,000	8.3	390	276	990	0.345	0.195	0.450	-
	"	11:20 A June 6	-	22	6.54	74.0	2.4	240,000	8.3	450	238	830	0.390	0.175	1.500	-
	"	7:42 A June 13	-	21	1.85	20.6	18.2	230,000	6.8	20,300	64	159	0.490	0.028	-	-
	"	6:41 A June 20	-	20	4.59	50.0	3.2	230,000	7.7	6,700	103	140	0.350	0.004	0.053	-
	"	11:27 A June 27	-	21	6.24	57.4	5.5	930,000	7.7	1,900	162	460	0.380	0.010	0.190	-

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LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO_4
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
Salt Creek	P - 26.4 Sa.C. - 22.0	10:08 A Apr. 28	-	16	7.40	74.4	9.8	-	8.3	90	312	1,250	1.000	0.095	0.180	-
Bridge - 3 miles east and 2 1/2 miles	"	8:12 A May 3	-	17	4.18	43.0	13.1	930,000	8.3	1,100	301	3,180	2.950	0.090	0.800	-
north of Lincoln	"	9:15 A May 16	-	19	5.37	57.4	6.7	1,500,000	8.2	280	322	1,450	0.850	0.115	1.000	-
	"	9:46 A May 26	-	17	7.12	73.1	3.0	230,000	7.7	900	227	530	0.260	0.012	2.050	-
	"	9:04 A May 31	-	18	5.31	55.7	4.6	230,000	8.2	300	297	1,080	0.750	0.160	1.000	-
	"	10:40 A June 6	-	22	5.52	62.5	4.4	150,000	7.9	310	300	1,170	0.850	0.195	1.000	-
	"	7:14 A June 20	-	19	4.62	49.4	3.8	930,000	8.3	5,500	135	400	0.395	0.003	0.055	-
	"	10:46 A June 27	-	22	5.07	57.5	9.7	150,000	7.7	1,400	239	780	0.750	0.002	0.076	-
Salt Creek	P - 26.4 Sa.C. - 25.0	8:35 A Apr. 28	-	14	5.71	55.1	8.1	>110,000	8.1	60	330	1,950	1.800	0.100	0.400	-
Bridge - northeast of Lincoln on	"	7:02 A May 3	-	17	5.83	39.4	15.6	2,400,000	8.1	1,200	301	3,270	2.750	0.080	0.700	-
Highway #77	"	6:42 A May 9	-	15	4.64	45.6	9.8	140,000	7.5	11,000	98	163	0.450	0.030	1.000	-
	"	8:16 A May 16	-	18	5.43	57.0	9.6	750,000	8.3	380	323	1,630	1.250	0.078	1.250	-
	"	8:49 A May 23	-	17	7.23	74.3	5.4	93,000	7.6	6,000	143	235	0.460	0.048	1.950	-
	"	6:53 A May 26	-	16	5.68	57.1	3.0	1,500,000	8.1	550	275	1,490	0.750	1.145	2.125	-
	"	7:26 A May 31	-	18	5.19	54.4	4.5	230,000	8.1	270	304	1,060	0.955	0.115	1.180	-
	"	7:51 A June 6	-	17	5.09	52.3	4.4	430,000	8.2	230	301	1,090	0.950	0.150	1.500	-
	"	5:35 A June 13	-	21	1.61	17.9	18.1	230,000	6.9	24,500	84	146	0.485	0.013	-	-
	"	9:44 A June 20	-	20	5.73	62.4	4.8	230,000	8.3	3,800	146	520	0.550	0.055	0.060	-
	"	8:03 A June 27	-	22	4.51	51.1	9.3	430,000	7.9	1,400	219	82	0.680	<0.001	0.084	-
Salt Creek	P - 26.4 Sa.C. - 37.1	9:15 A Apr. 28	-	15	8.10	79.7	4.3	2,300	8.3	150	289	34	<0.040	0.009	0.160	-
Bridge - 1 1/2 miles southwest of	"	7:38 A May 3	-	17	7.13	73.2	4.8	4,300	8.3	120	306	32	<0.040	0.005	0.500	-
the State Penitentiary -	"	7:32 A May 26	-	17	7.00	71.9	2.7	9,300	7.7	900	168	13	0.170	0.002	1.300	-
south of Lincoln	"	8:21 A May 31	-	19	6.14	65.7	2.9	9,300	8.3	400	278	24	0.150	0.055	0.710	-
	"	9:47 A June 6	-	21	6.38	71.1	2.8	9,300	8.2	260	302	29	0.090	0.031	0.750	-
	"	7:47 A June 20	-	19	5.31	56.8	8.7	240,000	8.3	5,000	124	16	0.195	0.055	0.055	-
	"	8:59 A June 27	-	21	5.82	64.8	4.9	15,000	7.5	1,500	160	15	0.250	<0.001	0.095	-
Platte River	P - 28.5 L	11:55 A Apr. 28	6,130	17	8.90	91.4	3.3	24,000	8.5	370	181	12	<0.040	0.005	0.110	-
Bridge - Highway #6 2 1/2 miles north-	" C	"		17	9.64	99.0	5.0	930	8.7	270	165	11	<0.040	0.001	0.020	-
east of Ashland	" R	"		17	9.97	102.4	3.5	2,300	8.7	220	166	11	<0.040	0.003	0.020	-
	" L	10:40 A May 3	6,490	16	8.40	86.3	4.0	15,000	8.5	250	184	8.7	<0.040	0.004	0.070	-
	" C	"		17	8.26	84.8	3.4	4,300	8.5	230	186	8.8	<0.040	0.003	0.060	-
	" R	"		17	8.28	85.1	3.9	9,300	8.5	240	187	8.4	<0.040	0.003	0.070	-
	" L	9:51 A May 9	8,350	16	9.01	90.5	4.1	7,500	8.3	700	163	7.7	<0.040	0.006	0.420	-
	" C	"		16	8.99	90.4	4.0	15,000	8.3	700	168	6.8	<0.040	0.005	0.320	-
	" R	"		16	9.08	91.3	4.2	4,300	8.3	700	169	7.2	<0.040	0.006	0.190	-
	" L	5:15 A May 13	6,980	-	7.69	-	4.3	4,300	8.7	180	188	7.6	-	-	-	-
	" C	"		-	8.11	-	3.7	[illegible],500	8.7	140	166	13	-	-	-	-
	" R	"		-	7.90	-	3.8	430	8.7	140	165	4.9	-	-	-	-
	" L	10:55 A May 16	6,980	20	8.22	89.6	4.2	930	8.7	200	179	18	<0.040	0.001	0.040	-
	" C	"		20	8.09	88.1	3.7	430	8.7	160	168	13	<0.040	0.002	0.040	-
	" R	"		20	8.21	89.5	2.8	930	8.7	170	166	8.8	<0.040	0.001	0.040	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO₄
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
Platte River	P - 28.5 L	7:17 A May 20	8,120	17	7.94	81.5	4.9	93,000	8.1	6,100	179	7.6	-	-	-	-
Bridge - Highway #6 2 1/2 miles north-east of Ashland	" C	"		17	8.74	89.7	3.7	4,300	8.6	1,100	161	14	-	-	-	-
	" R	"		17	8.71	89.5	3.1	9,300	8.6	900	160	15	-	-	-	-
	" L	11:39 A May 23	16,900	17	7.69	78.9	5.8	>110,000	7.6	7,500	116	4.4	0.240	0.022	0.900	-
	" C	"		17	7.51	77.1	6.2	>110,000	7.6	8,000	119	4.8	0.240	0.023	1.100	-
	" R	"		17	7.69	78.9	5.9	>110,000	7.6	8,200	118	5.0	0.230	0.021	0.130	-
	" L	11:21 A May 26	12,800	18	7.88	82.6	2.4	24,000	7.7	1,300	128	2.0	-	-	-	-
	" C	"		17	7.94	81.5	2.5	24,000	7.7	1,500	127	3.9	-	-	-	-
	" R	"		17	7.90	81.1	2.6	24,000	7.7	1,500	124	3.2	-	-	-	-
	" L	11:14 A May 31	10,600	19	7.40	79.1	3.1	43,000	8.3	2,000	156	5.1	<0.040	0.006	0.280	-
	" C	"		18	7.38	77.4	3.0	93,000	8.3	1,800	157	5.2	<0.040	0.006	0.280	-
	" R	"		18	7.61	79.8	3.4	43,000	8.2	1,700	160	5.1	<0.040	0.006	0.250	-
	" L	1:00 P June 6	10,200	21	7.08	78.8	2.6	75,000	7.7	2,100	117	2.9	-	-	-	-
	" C	"		21	7.36	81.9	2.8	23,000	7.8	1,500	122	9.0	-	-	-	-
	" R	"		22	7.54	85.3	3.0	43,000	7.7	1,800	127	12	-	-	-	-
	" L	9:10 A June 13	13,800	21	7.28	81.0	2.4	43,000	8.3	1,600	161	33	<0.040	0.003	-	-
	" C	"		21	7.08	78.8	2.1	23,000	8.3	1,900	164	2.7	<0.040	0.002	-	-
	" R	"		21	7.09	78.9	1.8	9,300	8.3	1,800	165	3.6	<0.040	0.003	-	-
	" L	5:17 A June 20	9,530	21	6.80	75.6	5.7	43,000	8.4	1,200	165	-	<0.040	<0.001	<0.020	-
	" C	"		22	6.70	75.9	6.1	23,000	8.4	1,000	164	-	<0.040	<0.001	<0.020	-
	" R	"		22	6.76	76.6	5.7	23,000	8.4	1,400	168	-	<0.040	<0.001	<0.020	-
	" L	12:56 P June 27	13,100	22	6.61	74.9	5.8	43,000	8.3	1,500	192	12	0.195	0.002	0.031	-
	" C	"		22	6.60	74.7	5.9	23,000	8.3	1,600	193	15	0.195	0.002	0.025	-
	" R	"		23	6.58	75.8	5.4	15,000	8.3	1,600	195	13	0.275	0.008	0.031	-
Platte River	P - 41.1 L	1:50 P Apr. 27	-	17	9.83	100.9	6.0	4,300	8.7	160	162	11	<0.040	<0.001	0.030	-
Bridge at Venice on the road to Wahoo	" R	"	-	17	9.70	99.6	6.5	4,300	8.7	160	165	11	<0.040	0.001	0.030	-
	" L	11:32 A May 3	-	17	8.77	90.2	3.5	730	8.6	200	156	10	<0.040	<0.001	0.030	-
	" R	"	-	17	8.82	90.6	4.3	360	8.6	170	156	10	<0.040	<0.001	0.030	-
	" L	11:16 A May 9	-	16	9.78	98.3	2.9	930	8.5	160	140	8.0	<0.040	<0.001	-	-
	" R	"	-	16	9.76	98.2	3.1	1,500	8.5	180	140	8.0	<0.040	<0.001	-	-
	" L	5:55 A May 13	-	-	8.25	-	3.0	930	8.7	130	160	10	-	-	-	-
	" R	"	-	-	8.17	-	3.1	430	8.7	130	165	15	-	-	-	-
	" L	11:44 A May 16	-	20	8.79	95.8	3.2	230	8.7	110	161	11	-	-	-	-
	" R	"	-	20	8.62	94.0	3.4	750	8.7	90	162	12	-	-	-	-
	" L	8:33 A May 20	-	16	9.26	93.1	3.8	9,300	8.7	280	159	11	-	-	-	-
	" R	"	-	16	9.10	91.5	3.1	4,600	8.7	320	161	13	-	-	-	-
	" L	12:21 P May 23	-	18	8.12	85.1	5.4	110,000	8.1	3,400	157	11	0.050	0.008	0.350	-
	" R	"	-	17	8.19	84.1	4.4	110,000	8.1	14,500	128	7.3	<0.040	0.002	0.180	-
	" L	11:57 A May 26	-	19	8.21	87.9	2.1	11,000	8.4	420	146	7.5	-	-	-	-
	" R	"	-	18	8.22	86.2	2.1	4,300	8.4	430	152	11	-	-	-	-
	" L	11:41 A May 31	-	18	8.06	84.5	4.5	4,300	8.6	300	150	8.9	<0.040	<0.001	<0.020	-
	" R	"	-	19	8.12	86.9	3.7	2,300	8.6	290	153	8.9	<0.040	<0.001	<0.020	-
	" L	1:45 P June 6	-	21	7.26	80.8	3.0	24,000	7.8	2,000	120	7.0	-	-	-	-
	" R	"	-	21	7.36	82.1	2.5	9,300	7.8	1,400	136	8.5	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m. NH3	NO2	NO3	PO4
Platte River Bridge at Venice on the road to Wahoo	P - 41.1 L	9:40 A June 13	-	21	7.25	80.7	2.0	4,300	8.6	650	140	11	<0.040	<0.001	-	-
	" R	"	-	21	7.21	80.3	1.6	4,300	8.5	580	139	12	<0.040	<0.001	-	-
	" L	4:39 A June 20	-	22	6.63	75.1	5.2	23,000	8.4	1,100	151	-	<0.040	<0.001	<0.010	-
	" R	"	-	22	6.49	73.4	5.6	23,000	8.4	1,300	151	-	<0.040	<0.001	<0.020	-
	" L	1:31 P June 27	-	21	6.88	76.5	4.6	910	8.7	190	201	24	0.1[illegible]	<0.001	<0.020	-
	" R	"	-	21	6.90	76.8	4.3	730	8.5	220	206	24	0.110	<0.001	<0.020	-
Platte River Bridge - 1 mile southeast of Leshara	P - 47.2	12:06 P Apr. 25	-	17	9.46	97.1	4.6	1,500	8.7	130	182	12	<0.040	0.002	0.100	-
Platte River Bridge - south of Fremont, U.S. Highway #77	P - 57.1 L	11:23 A Apr. 25	-	17	9.60	98.5	2.3	750	8.7	110	182	15	<0.040	0.004	0.090	-
	" R	"	-	17	9.43	96.8	4.2	2,100	8.7	120	192	16	<0.040	0.003	0.090	-
	" L	5:22 A Apr. 29	-	15	8.61	84.8	4.0	750	8.7	90	168	12	<0.040	<0.001	0.030	-
	" R	"	-	14	8.50	82.0	3.0	4,300	8.7	85	162	12	<0.040	<0.001	0.030	-
	" L	8:41 A May 5	-	18	8.10	86.1	3.4	930	8.6	140	158	10	<0.040	<0.001	-	-
	" R	"	-	19	7.94	85.3	3.8	4,600	8.7	120	158	13	<0.040	<0.001	-	-
	" L	10:24 A May 11	-	17	8.96	92.0	3.0	4,600	8.7	220	144	6.2	<0.040	0.005	0.050	-
	" R	"	-	17	8.94	91.8	3.6	1,500	8.7	190	158	16	<0.040	<0.001	<0.020	-
	" L	6:55 A May 13	-	-	8.10	-	3.4	930	8.7	140	164	11	-	-	-	-
	" R	"	-	-	7.90	-	2.6	230	8.7	100	171	17	-	-	-	-
	" L	10:20 A May 19	-	14	8.53	82.2	4.2	4,300	8.5	450	164	16	-	-	-	-
	" R	"	-	14	8.42	81.2	3.8	24,000	8.5	1,100	161	17	-	-	-	-
	" L	9:57 A May 20	-	16	9.02	90.7	3.5	4,300	8.7	1,300	174	14	-	-	-	-
	" R	"	-	16	8.99	90.3	3.9	9,300	8.5	500	160	17	-	-	-	-
	" L	11:00 A June 2	-	17	7.04	72.3	5.1	240,000	7.4	18,000	102	7.8	<0.040	0.003	0.450	-
	" R	"	-	17	6.96	71.6	4.0	240,000	7.5	15,000	100	7.1	0.050	0.003	0.450	-
	" L	9:02 A June 10	-	20	7.53	82.1	6.2	75,000	8.3	2,400	128	2.6	-	-	-	-
	" R	"	-	20	7.50	81.7	4.8	43,000	8.3	2,600	126	2.4	-	-	-	-
	" L	10:09 A June 17	-	21	7.43	82.7	2.7	4,300	8.5	550	158	12	-	-	-	-
	" R	"	-	21	7.44	82.8	3.8	7,500	8.5	650	156	12	-	-	-	-
	" L	8:47 A June 24	-	23	6.61	76.2	4.9	43,000	8.3	500	191	20	-	-	-	-
	" R	"	-	23	6.28	72.4	4.3	7,500	8.2	600	190	20	-	-	-	-
Platte River Bridge - 1/2 mile south of North Bend	P - 72.8 R	10:15 A Apr. 25	4,910	17	9.26	95.1	1.5	1,500	8.6	140	171	11	<0.040	<0.001	0.200	-
	" L	6:16 A Apr. 29	4,280	14	8.31	80.2	7.2	4,300	8.7	110	161	11	<0.040	<0.001	0.040	-
	" R	"	-	14	8.51	82.1	4.8	1,500	8.7	100	165	13	<0.040	<0.001	0.030	-
	" L	10:23 A Mar 5	4,700	18	8.36	90.0	3.3	930	8.5	180	150	6.9	<0.040	<0.001	-	-
	" R	"	-	18	8.28	86.9	3.3	4,600	8.5	120	154	14	<0.040	<0.001	-	-
	" L	11:23 A May 11	8,200	18	9.29	97.4	4.7	4,600	8.7	190	144	5.6	<0.040	0.005	0.080	-
	" R	"	-	18	9.01	94.4	4.2	2,100	8.7	110	166	18	<0.040	0.002	0.030	-
	" L	8:20 A May 13	6,360	-	8.74	-	2.6	4,300	8.7	150	152	5.3	-	-	-	-
	" R	"	-	-	8.49	-	3.0	930	8.7	100	170	16	-	-	-	-
	" L	8:08 A May 19	4,970	17	8.79	90.3	5.9	24,000	8.7	220	147	5.9	-	-	-	-
	" R	"	-	17	8.79	90.3	3.2	2,300	8.7	230	148	5.8	-	-	-	-
	" L	10:31 A May 20	6,320	17	9.38	96.3	3.7	7,500	8.6	320	147	5.6	-	-	-	-
	" R	"	-	17	9.26	95.1	3.9	4,300	8.6	350	160	16	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO$_4$
					p.p.m.	% Sat.							NH$_3$	NO$_2$	NO$_3$	
Platte River	P - 72.8 L	11:51 A June 2	20,300	17	6.59	67.6	7.4	240,000	7.4	17,800	105	1.4	0.195	0.006	0.650	-
Bridge - 1/2 mile south of North Bend	" R	"	-	16	6.36	63.9	8.6	240,000	7.4	17,000	114	3.9	<0.040	0.006	0.550	-
	" L	9:52 A June 10	20,100	19	7.25	77.6	6.3	15,000	8.3	2,700	114	1.4	0.110	0.011	0.180	-
	" R	"	-	19	7.43	79.6	6.2	43,000	8.4	2,600	113	0.2	0.090	0.009	0.300	-
	" L	11:14 A June 17	6,840	20	7.17	78.2	3.0	43,000	8.2	1,200	138	2.9	-	-	-	-
	" R	"	-	21	7.29	81.1	3.2	93,000	8.2	1,200	136	2.8	-	-	-	-
	" L	9:40 A June 24	10,800	22	6.93	78.5	4.9	23,000	7.9	450	158	8.5	-	-	-	-
	" R	"	-	23	6.70	77.2	5.1	43,000	8.1	500	164	8.2	-	-	-	-
Shell Creek	P - 83.5 Sh.Cr.-2[illegible].5	8:10 A Apr. 29	18	15	8.59	84.5	4.8	430	8.4	40	315	5.3	<0.040	<0.001	0.020	-
County Bridge - 3 1/2 miles east	"	12:16 P May 5	18	18	7.99	85.5	5.0	2,300	8.4	55	327	5.0	<0.040	<0.001	-	-
and 6 miles north of Columbus	"	1:52 P May 11	22	19	8.29	88.6	4.5	2,300	8.3	220	290	4.1	0.280	0.050	0.450	-
	"	11:19 A May 19	23	17	8.10	83.2	3.2	9,300	8.4	190	324	5.1	0.140	0.009	7.000	-
	"	10:27 A May 25	80	17	8.08	82.9	7.2	93,000	7.9	4,000	159	2.4	-	-	-	-
	"	10:51 A June 14	43	19	7.40	79.1	6.5	240,000	8.1	310	199	2.7	-	-	-	-
	"	2:40 P June 21	90	19	5.39	57.6	10.2	240,000	7.8	13,500	132	2.0	0.250	0.012	3.500	-
Lost Creek	P - 84.0 Lt.C. - 2.2	9:36 A Apr. 25	-	17	9.13	93.8	2.5	46,000	8.3	30	228	5.1	<0.040	0.009	0.600	-
County Bridge - 1 3/4 miles east	"	7:11 A Apr. 29	-	13	7.65	72.2	2.7	110,000	8.1	15	215	3.8	0.160	0.005	0.070	-
of Schuyler	"	10:47 A May 5	-	17	7.25	75.9	2.8	110,000	7.7	30	224	5.1	0.190	0.010	1.200	-
	"	12:11 P May 11	-	17	8.06	82.8	3.8	43,000	8.2	40	235	4.6	0.270	0.030	1.000	-
	"	9:22 A May 19	-	18	7.50	78.6	3.8	43,000	8.1	80	222	4.5	0.130	0.010	1.650	-
	"	10:09 A May 27	-	16	7.25	72.9	2.2	240,000	7.8	180	221	3.0	-	-	-	-
	"	1:18 P June 2	-	18	6.39	66.9	>6.4	430,000	7.4	1,000	134	4.5	0.160	0.024	0.950	-
	"	10:53 A June 10	-	18	7.35	77.1	2.0	43,000	8.4	130	236	2.3	0.155	0.023	0.500	-
	"	11:31 A June 14	-	18	7.79	81.6	7.1	230,000	8.7	180	219	3.7	-	-	-	-
	"	10:27 A June 24	-	19	7.01	75.0	5.2	93,000	7.9	150	212	4.9	-	-	-	-
Lost Creek	P - 84.0 Lt.C. - 6.5	9:16 A Apr. 25	-	16	10.24	103.0	1.8	91	8.3	20	212	4.5	<0.040	0.007	0.800	-
County Bridge - 1 1/2 miles south-	"	7:26 A Apr. 29	-	14	8.67	83.7	1.8	230	7.9	20	197	4.6	<0.040	0.004	1.300	-
west of Schuyler	"	11:11 A May 5	-	17	9.77	102.2	2.7	430	7.7	30	195	6.4	<0.040	0.008	1.600	-
	"	1:07 P May 11	-	18	8.47	88.9	3.6	930	8.2	55	233	3.3	0.060	0.015	1.300	-
	"	10:03 A May 19	-	18	8.00	83.9	2.3	4,300	7.7	75	202	3.5	0.110	0.016	1.300	-
	"	10:29 A May 27	-	17	7.34	75.4	3.1	2,300	7.8	150	241	3.3	-	-	-	-
	"	1:43 P June 2	-	17	6.08	62.4	>6.1	110,000	7.3	450	104	1.4	0.180	0.009	0.200	-
	"	11:24 A June 10	-	19	7.48	80.0	2.2	15,000	8.4	140	240	3.3	0.130	0.016	1.040	-
	"	12:06 P June 14	-	18	7.49	78.5	5.2	2,100	8.7	180	234	4.4	-	-	-	-
	"	10:50 A June 24	-	20	6.88	75.0	6.4	150,000	8.3	160	207	4.1	-	-	-	-
Platte River	P - 103.0	8:22 A Apr. 25	-	17	9.01	92.5	1.9	4,300	8.5	130	193	9.0	<0.040	<0.001	<0.020	-
Below confluence of Platte and Loup	"	11:35 A Apr. 29	-	15	9.82	96.7	2.4	15,000	8.7	85	188	20	<0.040	0.002	0.020	-
Rivers	"	12:53 P May 5	-	17	8.93	93.2	5.5	11,000	8.7	75	172	6.6	<0.040	<0.001	-	-
	"	1:25 P May 10	-	20	9.39	102.2	4.3	150,000	8.7	110	152	2.5	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO₄
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
Platte River	P - 115.0 L	10:30 A Apr. 29	2,350	15	9.59	94.4	3.9	750	8.7	50	178	8.4	<0.040	0.002	0.400	-
Bridge - 1 1/4 miles south of Duncan	" L	1:10 P May 4	2,560	25	8.51	101.5	4.3	230	8.7	50	177	25	<0.040	0.001	0.020	-
	" C	"		25	7.79	93.0	2.9	91	8.7	55	167	28	<0.040	0.001	0.020	-
	" R	"		25	7.99	95.4	3.1	91	8.7	45	163	27	<0.040	0.001	0.020	-
	" L	11:45 A May 10	4,120	18	9.12	95.7	3.6	4,600	8.5	100	182	17	-	-	-	-
	" C	"		18	9.58	100.0	4.9	930	8.7	120	164	23	-	-	-	-
	" R	"		18	9.25	97.1	4.3	430	8.6	120	170	23	-	-	-	-
	" L	11:31 A May 17	2,700	21	8.80	97.9	3.9	750	8.8	80	177	25	<0.040	0.003	-	-
	" C	"		21	8.35	93.0	2.7	93	8.7	100	164	27	<0.040	0.004	-	-
	" R	"		21	8.30	92.4	2.4	230	8.7	65	164	28	<0.040	0.001	-	-
	" L	10:13 A May 20	2,880	14	9.71	93.8	3.9	2,400	8.6	110	184	20	-	-	-	-
	" C	"		14	9.68	93.4	1.8	230	8.6	100	166	26	-	-	-	-
	" R	"		14	9.67	93.3	3.2	150	8.6	95	165	26	-	-	-	-
	" L	12:21 P May 24	3,050	16	9.51	95.5	4.0	4,300	8.7	120	193	16	-	-	-	-
	" C	"		16	9.53	95.7	2.1	1,500	8.7	160	165	22	-	-	-	-
	" R	"		16	9.47	95.2	3.6	2,300	8.7	200	165	23	-	-	-	-
	" L	1:40 P June 10	10,500	20	7.01	76.4	6.5	3,900	8.4	650	136	8.5	-	-	-	-
	" C	"		19	6.94	74.2	5.8	24,000	8.4	550	134	7.8	-	-	-	-
	" R	"		20	7.12	77.6	5.8	9,300	8.4	600	134	9.1	-	-	-	-
	" L	5:01 A June 14	5,980	21	6.43	71.6	5.1	23,000	7.5	450	105	3.9	-	-	-	-
	" C	"		21	7.92	88.2	6.7	1,500	8.3	210	183	24	-	-	-	-
	" R	"		20	7.52	82.0	1.6	<360	8.1	200	177	23	-	-	-	-
Platte River	P - 146.6	6:00 A May 10	-	13	8.80	83.0	2.2	430	8.5	90	169	24	<0.040	0.008	0.050	-
4 miles northeast of Central City	"	5:46 A May 17	-	18	7.73	81.0	3.0	930	8.7	70	193	19	<0.040	<0.001	0.090	-
where Prairie Island county road	"	9:10 A May 20	-	13	9.35	88.1	2.3	430	8.6	95	164	26	-	-	-	-
parallels river	"	5:45 A May 24	-	11	9.47	85.6	2.5	930	8.7	140	179	25	-	-	-	-
	"	3:19 P June 9	-	19	6.46	69.1	3.4	46,000	8.5	900	129	11	0.055	0.002	0.500	-
	"	5:55 A June 14	-	20	7.19	78.4	2.5	9,300	7.8	140	400	8.9	-	-	-	-
	"	2:29 P June 23	-	23	6.51	75.0	5.8	22,000	8.5	340	220	22	-	-	-	-
Platte River	P - 148.4 L	6:10 A May 4	-	21	7.86	87.5	1.7	2,300	8.6	35	189	26	<0.040	0.004	0.070	-
Bridge - 1 mile east of Central City	" R	"	-	21	7.80	86.8	1.8	91	8.5	30	170	29	<0.040	0.003	0.030	-
Platte River	P - 152.2	6:35 A May 4	-	20	7.88	85.9	1.8	930	8.6	35	190	25	<0.040	0.005	0.080	-
Bridge - 2 miles south of Central	"	6:25 A May 10	-	13	8.69	82.0	2.4	4,300	8.5	85	199	22	<0.040	0.015	0.400	-
City, Highway #14	"	6:16 A May 17	-	18	7.77	81.6	2.5	4,300	8.7	70	196	24	<0.040	<0.001	0.190	-
	"	8:38 A May 20	-	13	9.25	87.2	3.1	4,300	8.6	70	186	23	-	-	-	-
	"	6:24 A May 24	-	11	9.44	85.2	2.7	4,300	8.6	240	196	20	-	-	-	-
	"	2:50 P June 9	-	20	6.40	69.8	3.2	12,000	8.4	800	122	9.4	0.055	0.003	0.850	-
	"	6:22 A June 14	-	20	7.15	77.9	4.5	9,300	7.6	400	130	8.8	-	-	-	-
	"	2:04 P June 23	-	23	6.42	74.0	4.8	15,000	8.3	360	222	21	-	-	-	-
Wood River	P - 161.4 W.R. - 7.0	11:55 A May 2	-	18	7.96	83.5	7.4	9,300	7.9	90	204	15	-	-	-	-
County Bridge - 4 1/2 miles east of	"	11:45 A May 9	-	15	7.73	76.1	6.1	110,000	7.8	230	192	13	-	-	-	-
Grand Island																

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO$_4$
					p.p.m.	% Sat.							NH$_3$	NO$_2$	NO$_3$	
Wood River	P - 161.4 W.R. - 7.0	10:10 A May 10	-	16	7.53	75.6	6.3	93,000	7.7	200	196	-	0.400	0.010	0.400	-
County Bridge - 4 1/2 miles east of	"	10:32 A May 11	-	18	6.96	73.0	5.0	23,000	7.9	290	192	-	-	-	-	-
Grand Island	"	1:49 P May 16	58	22	6.12	69.4	8.3	23,000	7.7	100	205	-	-	-	-	-
	"	9:42 A May 17	58	17	6.66	68.4	5.1	75,000	7.8	90	209	-	0.700	0.050	1.400	-
	"	9:35 A May 18	58	18	6.10	64.0	6.7	240,000	7.8	90	213	-	-	-	-	-
	"	11:00 A May 23	150	14	6.71	64.8	6.7	43,000	7.8	650	180	12	0.500	0.025	1.400	-
	"	11:45 A May 24	-	15	7.51	74.1	5.4	9,300	7.8	350	184	16	0.600	0.030	1.400	-
	"	9:25 A May 25	130	16	7.06	71.0	5.7	4,300	7.9	230	197	14	-	-	-	-
	"	10:45 A May 31	-	21	6.18	68.8	4.8	23,000	7.9	170	196	14	-	-	-	-
	"	10:35 A June 6	82	20	6.74	73.5	5.9	150,000	7.9	2,500	121	6.7	-	-	-	-
	"	11:05 A June 15	380	21	6.96	77.5	3.2	43,000	7.7	2,000	131	8.4	-	-	-	-
	"	8:13 A June 20	108	20	6.26	68.3	5.0	23,000	7.8	1,100	173	11	0.800	0.012	1.600	-
	"	1:30 P June 23	168	25	5.32	63.4	7.0	150,000	7.7	3,700	134	5.2	0.400	0.017	3.200	-
	"	12:10 P July 5	56	27	5.43	67.3	12.0	43,000	7.6	1,100	159	14	0.600	0.150	2.400	1.60
	"	8:00 A July 7	49	24	5.26	61.7	6.8	15,000	7.7	800	168	15	0.075	0.096	3.000	2.00
Wood River	P - 161.4 W.R. - 9.0	11:45 A May 2	-	18	8.30	87.0	7.8	15,000	7.9	65	204	15	-	-	-	-
County Bridge - 3 miles east of	"	11:25 A May 9	-	15	8.11	79.9	5.3	>110,000	7.9	190	193	14	-	-	-	-
Grand Island	"	9:30 A May 10	-	15	7.67	75.5	6.1	93,000	7.9	180	193	-	0.420	0.007	-	-
	"	10:15 A May 11	-	17	7.16	73.6	6.2	9,300	7.9	300	186	-	-	-	-	-
	"	1:35 P May 16	56	22	6.05	68.6	9.0	43,000	7.9	70	196	-	1.000	0.080	0.600	-
	"	9:26 A May 17	56	17	6.84	70.3	3.8	46,000	7.9	80	206	-	-	-	-	-
	"	9:20 A May 18	56	18	6.65	69.7	5.8	110,000	7.9	85	209	-	-	-	-	-
	"	10:45 A May 23	150	15	7.10	69.9	5.3	93,000	7.9	600	181	13	0.600	0.015	1.400	-
	"	11:30 A May 24	-	15	7.80	76.8	6.5	23,000	7.8	300	187	14	0.800	0.030	0.400	-
	"	9:14 A May 25	130	16	7.33	73.7	6.4	7,500	7.9	220	202	17	-	-	-	-
	"	10:30 A May 31	-	21	5.99	66.7	5.0	9,300	7.9	120	194	15	-	-	-	-
	"	10:20 A June 6	80	20	6.83	74.4	6.2	23,000	7.9	2,500	125	8.1	-	-	-	-
	"	8:25 A June 13	-	21	5.33	59.3	3.1	15,000	7.5	1,400	106	5.2	0.200	0.010	0.400	-
	"	10:50 A June 15	375	21	7.00	77.8	3.6	240,000	7.5	2,600	121	8.6	-	-	-	-
	"	7:50 A June 20	105	20	6.30	68.7	5.2	43,000	7.8	1,000	168	10	0.300	0.004	1.600	-
	"	1:10 P June 23	165	25	5.50	65.7	6.8	39,000	7.7	3,700	134	5.2	0.500	0.007	1.400	-
	"	12:30 P July 5	54	27	6.04	74.9	12.9	23,000	7.7	1,000	162	12	1.400	0.085	2.800	1.40
	"	8:15 A July 7	47	24	5.20	60.9	7.3	29,000	7.7	800	171	14	0.850	0.064	2.200	1.50
Wood River	P - 161.4 W.R. - 13.0	11:20 A May 2	60	15	10.70	105.4	3.9	7,500	8.2	35	216	13	-	-	-	-
Bridge - 1/2 mile south of Grand	"	10:50 A May 9	150	13	8.67	81.8	5.2	>110,000	7.9	190	206	13	-	-	-	-
Island, U.S.Highway #34 and #281	"	9:10 A May 10	160	15	8.00	78.8	4.8	46,000	7.8	250	187	-	0.140	0.002	0.320	-
	"	9:54 A May 11	100	17	7.82	80.4	3.9	4,300	7.9	240	188	-	-	-	-	-
	"	12:51 P May 16	35	20	8.23	89.8	3.1	2,300	8.0	70	209	-	<0.040	0.008	0.600	-
	"	9:07 A May 17	35	16	8.49	85.3	3.3	4,300	8.0	65	215	-	0.040	0.010	1.400	-
	"	9:05 A May 18	35	16	8.65	86.9	3.7	3,900	7.9	80	211	-	-	-	-	-
	"	10:25 A May 23	130	15	7.91	78.0	3.2	24,000	7.9	700	179	11	0.100	0.007	0.400	-
	"	11:14 A May 24	115	15	8.69	85.6	3.1	9,300	7.9	290	187	14	0.080	0.007	0.280	-
	"	8:45 A May 25	110	16	8.11	81.6	2.8	24,000	8.1	200	205	14	-	-	-	-
	"	10:03 A May 31	-	20	7.70	84.0	2.1	4,300	7.9	120	200	10	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO$_4$
					p.p.m.	% Sat.							NH$_3$	NO$_2$	NO$_3$	
Wood River	P - 161.4 W.R. - 13.0	10:05 A June 6	58	19	8.13	87.0	3.6	24,000	7.8	2,600	114	4.9	-	-	-	-
Bridge - 1/2 mile south of Grand	"	12:20 P June 7	200	16	7.22	72.5	4.8	>110,000	7.5	3,300	94	2.1	-	-	-	-
Island, U.S.Highway #34 and #281	"	8:06 A June 13	1,300		5.48	61.0	2.8	24,000	7.5	1,800	100	3.9	0.160	0.017	0.320	-
	"	10:30 A June 15	350	20	7.33	79.9	2.9	46,000	7.6	3,000	116	6.8	-	-	-	-
	"	7:35 A June 20	80	19	7.13	76.3	2.5	24,000	7.9	1,100	174	9.6	0.150	0.004	1.600	-
	"	12:56 P June 23	140	26	6.39	77.8	3.8	110,000	7.7	3,300	121	3.9	0.100	0.001	2.000	-
	"	1:10 P July 5	34	27	6.68	82.7	2.8	15,000	7.9	1,300	148	6.7	0.060	0.004	1.600	1.00
	"	8:50 A July 7	27	23	7.29	84.0	2.6	9,300	7.9	900	162	7.5	0.045	<0.001	1.800	1.20
Wood River	P - 161.4 W.R. - 77.5	11:20 A May 3	4.6	19	7.37	78.8	>7.4	930	8.4	120	359	7.9	-	-	-	-
Bridge - 1 1/2 miles northeast of	"	2:00 P May 6	8	16	5.61	56.4	6.6	430	7.7	95	362	8.3	-	-	-	-
Riverdale, State Highway #40	"	11:20 A May 10	10	15	6.78	66.8	4.2	9,300	8.3	75	336	-	0.340	0.012	0.600	-
	"	1:34 P May 12	8.4	19	6.86	73.4	5.6	9,300	8.1	80	320	-	0.300	0.017	0.400	-
	"	11:15 A May 17	5.5	19	5.10	54.6	5.0	930	7.8	100	340	-	0.140	0.035	0.400	-
	"	1:45 P May 19	20	16	6.43	64.6	5.6	4,300	7.6	600	185	4.4	-	-	-	-
	"	1:00 P May 26	5	20	5.29	57.7	4.7	4,300	7.7	160	236	3.0	-	-	-	-
	"	3:30 P June 2	10	21	7.99	88.9	6.8	930	8.2	120	305	5.2	-	-	-	-
	"	3:50 P June 9	438	18	6.30	66.1	5.0	460,000	7.2	7,000	56	1.6	0.200	0.007	0.400	<0.005
	"	3:15 P June 14	168	20	4.58	49.9	12.6	430,000	7.5	7,000	105	2.6	-	-	-	-
	"	4:40 P June 16	22	24	5.64	66.1	3.9	9,300	7.7	350	201	5.0	-	-	-	-
Platte River	P - 173.2	10:55 A May 2	1,960	18	9.30	97.5	3.7	91	8.4	45	199	27	-	-	-	-
Bridge - 4 miles southeast of	"	10:25 A May 9	3,560	14	9.85	95.0	1.8	2,400	8.3	50	194	24	-	-	-	-
Grand Island, State Highway #2	"	8:45 A May 10	2,770	15	9.15	90.1	1.4	2,400	8.5	40	192	-	0.010	<0.001	0.120	-
	"	9:25 A May 11	2,340	18	8.86	92.9	1.9	430	8.4	25	205	-	-	-	-	-
	"	12:36 P May 16	2,280	22	8.52	96.5	3.1	360	8.6	50	200	-	<0.040	0.002	0.120	-
	"	8:35 A May 17	1,910	18	8.81	92.4	2.5	2,300	8.5	40	197	-	<0.040	0.001	-	-
	"	8:50 A May 18	1,990	18	8.95	93.9	2.0	430	8.5	40	189	-	-	-	-	-
	"	10:10 A May 23	2,650	15	8.85	87.1	1.6	930	8.5	55	196	26	<0.040	0.003	0.280	-
	"	11:00 A May 24	2,740	15	9.25	91.1	2.5	15,000	8.4	330	199	24	<0.040	<0.001	0.280	-
	"	8:29 A May 25	2,710	17	8.81	90.4	2.3	9,300	8.4	220	195	23	-	-	-	-
	"	9:50 A May 31	1,650	22	7.79	88.2	2.2	430	8.6	70	198	5	-	-	-	-
	"	9:45 A June 6	1,480	23	8.62	99.4	2.9	2,300	8.3	140	192	24	-	-	-	-
	"	12:10 P June 7	2,490	17	8.91	91.5	3.3	2,100	8.3	140	166	20	-	-	-	-
	"	7:50 A June 13	2,710	21	7.51	83.5	1.9	9,300	8.4	240	210	23	0.070	<0.001	0.320	-
	"	10:10 A June 15	1,960	22	8.69	98.4	2.6	24,000	8.2	190	229	25	-	-	-	-
	"	7:15 A June 20	7,310	22	6.38	72.3	4.2	9,300	8.3	210	198	20	0.100	0.008	0.040	-
	"	12:40 P June 23	7,570	29	6.61	85.1	3.5	1,500	8.4	45	220	25	0.100	0.001	0.280	-
	"	12:50 P July 5	4,150	31	7.27	96.3	3.2	430	8.7	70	232	29	0.040	<0.001	0.120	0.25
	"	8:30 A July 7	4,350	28	6.71	84.8	4.4	2,300	8.5	150	215	30	<0.040	<0.001	0.160	0.20
Platte River	P - 191.8	2:45 P May 16	-	24	7.81	91.6	2.4	430	8.5	35	171	-	<0.040	0.001	0.060	-
Bridge - 7 miles south of Wood River,	"	10:30 A May 17	-	19	8.62	92.3	1.9	230	8.5	30	186	-	<0.040	0.003	0.200	-
State Highway #80	"	10:40 A May 18	-	20	8.65	94.4	2.0	430	8.4	45	167	-	-	-	-	-
	"	9:20 A May 23	-	15	9.17	90.3	1.4	930	8.4	45	180	25	<0.040	0.001	0.280	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO₄
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
Platte River	P - 191.8	12:46 P May 24	-	16	8.51	85.6	2.5	46,000	8.4	600	171	24	<0.040	0.001	0.280	-
Bridge - 7 miles south of Wood River	"	10:10 A May 25	-	18	8.61	90.3	2.0	4,300	8.4	400	178	26	-	-	-	-
State Highway #60	"	11:46 A May 31	-	23	7.81	90.0	2.5	230	8.7	25	177	27	-	-	-	-
	"	8:50 A June 6	-	22	8.30	94.0	1.5	150	8.3	40	176	26	-	-	-	-
	"	1:25 P June 7	-	17	9.15	93.9	2.0	2,300	8.3	30	168	23	-	-	-	-
	"	6:50 A June 13	-	20	7.59	82.7	2.0	4,300	8.4	240	185	27	0.070	<0.001	0.320	-
	"	11:50 A June 15	-	24	8.36	98.1	2.6	2,300	8.6	160	180	28	-	-	-	-
	"	6:25 A June 20	-	22	6.01	68.0	3.2	930	8.2	85	188	22	-	-	-	-
	"	2:20 P June 23	-	29	6.60	85.0	4.4	430	8.4	40	199	26	0.140	0.001	0.160	-
	"	2:25 P July 5	-	32	7.27	98.4	4.8	230	8.7	45	219	32	0.060	<0.001	0.080	0.15
	"	9:45 A July 7	-	29	7.14	91.9	5.0	930	8.4	120	172	27	<0.040	<0.001	0.200	0.05
Turkey Creek	P - 210.1 T.Cr. - 0.6	10:10 A May 3	-	19	8.68	92.5	2.0	43,000	8.4	30	204	25	-	-	-	-
County Bridge - 6 miles southeast	"	11:20 A May 10	-	18	8.96	94.1	3.0	9,300	8.3	45	200	-	<0.040	0.002	0.400	-
of Kearney	"	12:02 P May 11	-	18	8.61	90.4	3.0	15,000	8.4	50	211	-	-	-	-	-
	"	11:25 A May 17	-	19	8.71	93.2	2.9	15,000	8.5	35	203	-	0.040	0.007	0.280	-
	"	1:50 P May 24	-	17	8.62	88.5	4.4	4,300	8.4	310	199	19	0.040	0.002	0.240	-
	"	11:10 A May 25	-	18	9.60	100.8	3.2	46,000	8.4	10	257	30	-	-	-	-
	"	12:56 P May 31	-	24	6.29	73.8	8.5	240,000	8.1	190	220	24	-	-	-	-
	"	2:30 P June 7	-	16	7.43	74.7	5.0	240,000	7.6	1,800	112	11	-	-	-	-
	"	12:40 P June 15	-	24	7.67	90.0	2.8	43,000	8.3	240	202	24	-	-	-	-
	"	3:45 P June 23	-	28	6.52	82.3	5.1	2,100,000	8.4	160	222	26	0.280	0.002	<0.020	-
	"	3:25 P July 5	-	31	7.49	99.8	4.0	240,000	8.5	95	226	32	0.070	<0.001	0.200	0.30
	"	2:05 P July 6	-	29	8.34	107.2	5.7	4,300	8.5	130	211	29	0.040	<0.001	0.200	0.20
	"	10:35 A July 7	-	27	6.35	78.6	8.2	39,000	8.0	1,200	188	26	0.070	<0.001	0.240	0.30
Turkey Creek	P - 210.1 T. Cr. - 4.6	9:15 A May 3	0	16	8.51	85.6	5.5	93,000	8.4	20	217	30	-	-	-	-
County Bridge - 3 miles southeast	"	11:45 A May 10	0	18	8.33	87.4	4.6	43,000	7.9	7	261	-	0.280	0.001	-	-
of Kearney	"	12:29 P May 11	0	17	7.92	81.3	5.5	93,000	8.1	6	263	-	-	-	-	-
	"	11:45 A May 17	0	17	10.12	104.0	4.2	75,000	8.3	10	234	-	0.140	0.035	0.400	-
	"	1:19 P May 24	0	18	9.92	104.0	9.3	930,000	8.1	30	274	29	1.600	0.001	0.240	-
	"	10:50 A May 25	0	17	8.40	86.3	3.0	93,000	8.1	290	205	19	-	-	-	-
	"	12:41 P May 31	-	23	6.18	71.3	6.2	43,000	8.1	140	215	24	-	-	-	-
	"	1:00 P June 15	-	23	5.57	66.2	6.3	210,000	7.9	240	235	26	-	-	-	-
	"	3:25 P June 23	-	30	6.07	79.6	3.0	43,000	8.4	50	218	25	0.140	0.002	0.280	-
	"	3:45 P July 5	-	29	5.41	69.6	9.3	460,000	7.9	[illegible]	231	32	0.200	0.002	0.240	0.25
	"	1:40 P July 6	-	29	6.24	80.3	6.4	46,000	8.1	230	220	31	0.280	<0.001	0.480	0.20
	"	10:50 A July 7	-	28	5.86	74.0	7.6	240,000	7.9	1,300	160	19	0.165	<0.001	0.600	0.70
Kearney Canal	P - 210.1 T.Cr. - 5.6	8:35 A May 3	2	18	5.92	62.0	11.7	<360	8.0	120	185	26	-	-	-	-
Bridge - 1/2 mile west of Kearney	K.Can.- 3.5 "	12:15 P May 6	3	16	4.98	50.0	13.4	1,500	7.7	200	168	24	-	-	-	-
city limits	"	2:00 P May 9	2	18	9.82	103.0	10.1	4,300	8.1	270	100	12	-	-	-	-
	"	2:35 P May 11	2	22	7.80	88.3	11.3	1,500	7.7	320	109	-	-	-	-	-
	"	12:45 P May 31	-	23	7.10	81.8	2.0	4,300	8.4	100	200	23	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO₄
					p.p.m.	% Sat.							NH₃	NO₂	NO₃	
Kearney Canal	P - 210.1 T.Cr. - 6.6	3:10 P June 8	-	18	7.37	77.4	4.7	24,000	7.4	2,000	68	0.9	-	-	-	-
Bridge - 1/2 mile west of Kearney	K.Can. - 3.8 "	1:40 P June 10	-	22	6.19	70.1	4.1	46,000	7.6	2,900	94	3.5	-	-	-	-
city limits	"	2:10 P June 24	-	25	6.18	73.8	2.1	7,500	8.2	130	213	24	0.100	<0.001	0.240	0.25
	"	12:55 P July 6	-	28	6.95	87.8	3.6	15,000	8.5	260	218	28	0.040	<0.001	0.280	0.30
Platte River	P - 224.8	8:00 A May 3	1,830	17	8.89	91.2	2.5	230	8.5	65	186	25	-	-	-	-
County Bridge - 2 1/2 miles south	"	11:50 A May 6	1,880	14	9.38	90.4	2.2	430	8.4	45	181	24	-	-	-	-
of Odessa	"	1:20 P May 9	1,780	18	9.25	97.0	2.5	9,300	8.2	45	183	31	-	-	-	-
	"	2:15 P May 11	1,930	22	8.41	95.3	2.1	930	8.6	35	200	-	-	-	-	-
	"	1:15 P May 13	2,160	21	8.40	93.5	2.1	150	8.5	30	202	-	-	-	-	-
	"	1:55 P May 18	1,780	24	7.83	91.9	2.5	11,000	8.4	370	175	-	-	-	-	-
	"	2:00 P May 20	1,640	16	8.82	88.6	1.8	930	8.5	50	172	28	-	-	-	-
	"	12:40 P May 25	2,680	23	7.93	91.4	1.7	4,300	8.4	180	204	19	-	-	-	-
	"	11:50 A May 27	2,190	24	7.89	92.5	1.0	930	8.5	80	205	22	-	-	-	-
	"	12:20 P May 31	1,100	23	7.88	90.8	1.6	430	8.6	25	185	25	-	-	-	-
	"	3:20 P June 1	1,280	22	7.69	87.2	2.6	9,300	8.2	60	156	25	-	-	-	-
	"	12:40 P June 3	1,020	19	8.87	94.8	1.3	430	8.3	30	176	28	-	-	-	-
	"	2:40 P June 8	4,910	18	7.43	77.9	4.5	46,000	7.4	1,400	83	1.1	-	-	-	-
	"	1:15 P June 10	2,780	24	6.79	79.5	4.0	24,000	7.8	1,400	133	11	-	-	-	-
	"	3:45 P June 24	13,500	23	6.52	77.8	1.7	2,300	8.3	25	192	22	0.140	<0.001	0.280	0.10
	"	12:30 P July 6	3,440	29	8.13	104.5	3.8	9,300	8.4	100	202	27	0.040	<0.001	0.160	0.20
	"	1:15 P July 8	2,520	28	7.19	90.7	4.7	3,900	8.3	160	176	23	<0.040	<0.001	0.200	0.20
Platte River	P - 241.2	11:35 P May 5	1,770	20	8.59	93.7	1.2	230	8.5	55	194	24	-	-	-	-
Bridge - 3 1/2 miles southeast of Overton	"	1:40 P May 11	2,180	21	8.43	93.8	2.2	430	8.4	20	204	-	-	-	-	-
private road	"	1:20 P May 13	2,380	21	8.45	94.0	4.4	230	8.4	30	200	-	-	-	-	-
	"	1:15 P May 18	2,090	24	8.09	94.8	1.6	930	8.5	30	209	-	-	-	-	-
	"	1:17 P May 20	1,880	16	8.51	85.7	1.5	4,300	8.4	35	208	21	-	-	-	-
	"	12:10 P May 25	2,580	21	8.48	94.4	1.3	4,300	8.4	30	209	20	-	-	-	-
	"	11:20 A May 27	2,250	22	7.89	89.3	1.4	2,100	8.5	45	220	22	-	-	-	-
	"	11:50 A May 31	1,430	23	7.60	87.5	1.1	2,300	8.4	30	218	24	-	-	-	-
	"	1:55 P June 1	1,440	22	7.34	83.3	3.2	24,000	8.2	350	200	23	-	-	-	-
	"	12:10 P June 3	1,090	18	8.34	87.5	1.0	2,300	8.2	30	210	25	-	-	-	-
	"	10:40 A June 10	2,480	21	7.67	85.4	1.9	24,000	8.5	120	200	20	-	-	-	-
	"	3:10 P June 24	14,700	24	5.86	68.8	1.5	2,300	8.0	15	201	24	0.080	<0.001	0.160	0.10
Plum Creek	P - 245.6 P.C. - 3.7	11:20 A July 6	0	25	6.05	72.2	3.6	9,300	7.5	450	110	1.1	0.120	<0.001	1.400	1.500
County Bridge - 8 miles south of																
Lexington																
Platte River	P - 252.5	12:10 P May 5	-	18	8.51	89.3	[illegible]	930	8.5	25	209	21	-	-	-	-
Bridge - 2 1/2 miles south of	"	11:08 A May 9	-	14	9.78	[illegible]	2.4	15,000	8.1	40	205	24	-	-	-	-
Lexington - U.S.Highway #283	"	1:00 P May 11	-	21	8.41	93.6	1.7	930	8.4	20	204	-	-	-	-	-
	"	12:30 P May 13	-	20	7.98	87.0	0.5	230	8.4	25	221	-	-	-	-	-
	"	12:32 P May 18	-	22	8.45	95.7	1.2	430	8.4	25	217	-	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m. NH$_3$	Nitrogen - N p.p.m. NO$_2$	Nitrogen - N p.p.m. NO$_3$	PO$_4$
Platte River	P - 252.7	12:40 P May 20	-	16	9.08	91.4	1.2	2,300	8.4	7	227	21	-	-	-	-
Bridge - 2 1/2 miles south of	"	11:35 A May 25	-	21	8.80	97.9	1.1	4,300	8.4	30	226	21	-	-	-	-
Lexington -	"	10:15 A May 27	-	22	8.02	90.8	0.7	930	8.4	35	210	23	-	-	-	-
	"	11:10 A May 31	-	23	8.19	94.3	1.1	750	8.4	20	224	22	-	-	-	-
	"	12:50 P June 1	-	22	8.59	97.3	1.5	2,300	8.3	20	218	23	-	-	-	-
	"	11:25 A June 3	-	16	9.20	92.4	1.1	1,500	8.3	15	211	23	-	-	-	-
	"	1:45 P June 8	-	18	8.32	87.3	2.3	7,500	7.9	280	192	18	-	-	-	-
	"	10:05 A June 10	-	21	8.22	91.5	1.1	15,000	8.4	65	220	22	-	-	-	-
	"	2:30 P June 24	-	24	6.47	75.9	2.9	910	8.2	40	185	25	0.080	<0.001	0.240	0.20
	"	10:50 A July 6	-	26	7.57	92.1	3.4	46,000	8.1	170	210	29	0.040	<0.001	0.480	0.20
Platte River	P - 265.1	12:01 P May 18	-	20	8.50	92.7	0.8	9,300	8.1	3	211	-	-	-	-	-
3 1/2 miles southeast of Cozad -	"	9:40 A May 27	-	20	8.12	89.2	1.1	4,300	8.4	35	206	18	-	-	-	-
no bridge	"	12:00 N June 1	-	21	8.09	90.0	2.3	430	8.1	3	213	20	-	-	-	-
	"	10:05 A July 6	-	25	6.56	78.3	2.9	24,000	8.1	140	213	31	0.050	<0.001	0.800	0.20
Platte River	P - 266.7 L	11:10 P May 5	60	18	8.40	88.1	1.5	24,000	8.5	30	181	17	-	-	-	-
County Bridge - 2 miles south of	" R	"	189	17	8.45	86.7	1.4	2,300	8.5	45	187	19	-	-	-	-
Cozad	" L	12:10 P May 11	89	19	8.62	92.1	2.0	4,300	8.4	15	160	-	-	-	-	-
	" R	"	392	19	9.06	96.9	2.2	2,300	8.4	10	201	-	-	-	-	-
	" L	11:00 A May 13	75	19	8.52	91.2	1.3	2,300	8.4	20	197	-	-	-	-	-
	" R	"	247	19	8.90	95.2	1.3	1,500	8.5	20	210	-	-	-	-	-
	" L	11:34 A May 20	55	16	8.72	87.6	1.4	4,300	8.4	20	198	15	-	-	-	-
	" R	"	263	16	8.98	90.3	1.2	46,000	8.4	25	203	16	-	-	-	-
	" L	9:15 A May 27	14	20	8.13	88.7	0.5	4,300	8.0	10	197	17	-	-	-	-
	" R	"	290	19	8.11	86.8	0.8	2,300	8.1	35	206	19	-	-	-	-
	" L	9:45 A May 31	9	21	9.38	104.2	1.0	9,300	8.4	5	196	18	-	-	-	-
	" R	"	221	21	7.90	87.9	0.8	4,300	8.4	25	196	18	-	-	-	-
	" L	11:20 A June 1	5	21	8.45	94.0	0.9	4,300	8.2	15	201	20	-	-	-	-
	" R	"	144	20	8.88	96.8	1.8	2,300	8.1	7	192	17	-	-	-	-
	" L	10:44 A June 3	82	15	8.96	78.3	1.4	9,300	8.3	20	193	18	-	-	-	-
	" R	"	81	15	7.83	77.1	0.6	930	8.3	30	212	24	-	-	-	-
	" L	12:30 P June 8	903	16	8.29	83.3	2.2	24,000	7.9	210	184	15	-	-	-	-
	" R	"	31	16	8.19	82.3	1.3	9,300	7.9	140	215	20	-	-	-	-
	" L	9:15 A June 10	515	19	7.91	84.6	1.2	7,500	8.5	50	211	18	-	-	-	-
	" R	"	31	18	8.20	86.0	0.7	2,300	8.4	30	221	25	-	-	-	-
	" L	1:20 P June 24	3,000	23	5.20	59.9	1.3	2,300	8.4	65	182	26	0.140	<0.001	0.280	0.15
	" R	"	9,570	23	5.32	61.3	1.4	1,500	8.4	90	184	24	0.060	<0.001	0.280	0.20
	" L	9:45 A July 6	206	25	7.37	87.9	3.1	24,000	8.3	160	204	31	0.040	<0.001	0.320	0.20
	" R	"	1,020	24	6.83	80.0	2.3	24,000	8.3	190	206	29	0.040	<0.001	0.600	0.20
	" L	11:05 A July 8	129	25	7.24	86.4	2.3	9,300	8.3	120	176	19	<0.040	0.001	0.160	0.10
	" R	"	774	25	7.34	87.6	3.0	4,300	8.1	120	185	20	0.065	<0.001	0.200	0.05

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO_4
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
Platte River	P - 272.0	9:40 A May 5	-	17	8.28	85.1	2.0	24,000	8.2	40	175	26	-	-	-	-
County Bridge - 5 miles southeast of	"	11:10 A May 11	-	17	8.51	87.3	2.1	2,300	8.4	10	231	-	-	-	-	-
Gothenburg on Willow Island	"	10:30 A May 13	-	19	8.22	88.0	1.3	4,300	8.5	20	189	-	-	-	-	-
	"	10:38 A May 20	-	16	8.51	85.7	1.1	46,000	8.4	25	190	13	-	-	-	-
	"	10:00 A May 25	-	18	8.37	87.8	1.2	9,300	8.4	30	202	12	-	-	-	-
	"	8:45 A May 27	-	20	7.67	83.8	0.9	46,000	8.3	40	192	14	-	-	-	-
	"	10:15 A June 1	-	20	8.09	88.3	1.3	7,500	8.3	25	176	14	-	-	-	-
	"	10:15 A June 3	-	17	8.61	86.5	1.4	9,300	8.3	25	183	15	-	-	-	-
	"	8:40 A June 10	-	19	7.84	83.8	1.1	2,300	8.5	35	202	14	-	-	-	-
	"	1:10 P June 24	-	22	6.49	73.4	1.9	9,300	7.9	240	179	25	0.060	0.001	0.280	0.20
	"	10:45 A July 8	-	25	7.15	85.4	2.8	46,000	8.4	120	168	17	0.040	0.001	0.160	0.10
Platte River	P - 277.8	9:05 A May 5	-	15	8.42	82.9	1.1	430	8.2	5	182	4.1	-	-	-	-
Foot Bridge - 1/2 mile southwest of	"	10:45 A May 11	-	16	8.59	86.3	1.5	230	8.3	10	193	-	-	-	-	-
Gothenburg	"	10:10 A May 13	-	17	8.55	87.8	0.8	91	8.4	3	195	-	-	-	-	-
	"	10:04 A May 18	-	18	8.11	85.0	0.7	200	8.4	7	196	-	-	-	-	-
	"	10:11 A May 20	-	14	7.27	70.2	1.0	1,500	8.0	5	204	15	-	-	-	-
	"	9:40 A May 25	-	18	8.32	87.3	0.9	230	8.4	15	201	13	-	-	-	-
	"	8:25 A May 27	-	17	8.42	86.5	0.3	91	8.2	5	196	14	-	-	-	-
	"	9:55 A June 1	-	19	8.78	94.0	1.0	230	8.3	3	186	14	-	-	-	-
	"	9:53 A June 3	-	14	8.11	78.2	0.6	430	8.2	5	192	16	-	-	-	-
	"	12:15 P June 8	-	15	8.30	81.7	1.8	930	8.1	10	197	11	-	-	-	-
	"	8:20 A June 10	-	18	7.95	83.3	1.0	390	8.5	15	208	14	-	-	-	-
	"	12:40 P June 24	-	22	6.03	68.4	1.3	2,300	8.1	250	176	26	0.140	<0.001	0.280	0.20
	"	10:15 A July 8	-	25	7.12	85.0	2.2	2,300	8.3	160	168	16	0.040	0.001	0.160	0.10
Platte River	P - 291.5 L	11:40 A May 5	93	16	9.52	95.7	1.4	930	8.3	5	163	5.7	-	-	-	-
County Bridge at Brady	" L	9:35 A May 11	182	15	9.08	89.4	1.7	230	8.4	7	187	-	-	-	-	-
	" C	"	-	14	9.45	91.2	2.2	1,500	7.9	5	244	-	-	-	-	-
	" R	"	88	15	9.00	88.6	1.8	91	8.3	6	208	-	-	-	-	-
	" L	8:50 A May 13	123	15	8.82	68.9	1.0	230	8.4	20	182	-	-	-	-	-
	" C	"	-	13	6.56	61.9	1.5	930	8.0	8	242	-	-	-	-	-
	" R	"	76	15	8.37	82.5	1.4	640	8.4	5	202	-	-	-	-	-
	" L	9:40 A May 20	99	14	8.21	79.3	1.3	750	7.9	7	170	5.2	-	-	-	-
	" C	"	-	14	6.39	61.7	1.7	4,300	7.9	6	243	34	-	-	-	-
	" R	"	65	14	8.65	83.4	1.5	280	8.1	8	204	19	-	-	-	-
	" L	8:20 A May 25	165	15	7.48	73.7	1.3	430	7.9	5	201	5.3	-	-	-	-
	" C	"	-	15	6.71	66.1	1.3	230	7.9	10	252	38	-	-	-	-
	" R	"	116	16	8.79	88.4	1.3	430	8.1	15	212	20	-	-	-	-
	" L	7:20 A May 27	120	16	7.09	71.3	0.9	9,300	7.9	10	193	6.9	-	-	-	-
	" C	"	-	16	5.29	53.2	2.2	430	7.7	20	244	37	-	-	-	-
	" R	"	94	16	7.59	76.3	0.9	4,300	7.9	30	207	20	-	-	-	-
	" L	9:30 A June 1	150	17	8.43	86.5	1.1	430	8.1	5	174	4.7	-	-	-	-
	" C	"	-	17	7.02	72.2	1.1	430	7.9	5	235	36	-	-	-	-
	" R	"	70	17	8.60	88.3	1.3	930	8.1	15	201	19	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO$_4$
					p.p.m.	% Sat.							NH$_3$	NO$_2$	NO$_3$	
Platte River	P - 291.5 L	9:13 A June 3	84	14	8.13	78.4	1.1	230	8.2	3	168	2.1	-	-	-	-
County Bridge at Brady	" C	"	-	14	5.88	56.7	1.2	930	8.3	5	236	35	-	-	-	-
	" R	"	65	15	8.41	82.9	1.2	430	8.2	15	200	20	-	-	-	-
	" L	10:50 A June 8	223	16	7.85	78.9	1.6	430	7.9	7	216	1.9	-	-	-	-
	" C	"	-	15	7.33	72.2	1.3	1,500	7.8	5	245	35	-	-	-	-
	" R	"	133	15	8.70	85.6	0.9	3,900	8.0	10	224	21	-	-	-	-
	" L	7:30 A June 10	204	17	6.73	69.1	1.0	230	8.3	7	217	4.3	-	-	-	-
	" C	"	-	16	5.41	54.4	0.6	2,300	8.0	7	248	39	-	-	-	-
	" R	"	98	17	7.72	79.3	0.9	750	8.4	15	209	21	-	-	-	-
	" L	11:30 A June 24	11,400	22	5.27	59.7	2.4	930	8.0	260	177	25	0.140	<0.001	0.320	0.25
	" C	"	-	22	4.84	54.8	2.1	2,300	8.4	120	187	28	0.140	<0.001	0.280	0.20
	" R	"	129	21	7.37	82.1	1.7	930	8.4	20	200	24	0.040	<0.001	0.280	0.05
	" L	9:50 A July 8	728	25	6.88	82.1	1.8	9,300	8.1	200	165	15	0.045	0.001	0.200	0.10
	" C	"	-	21	5.53	61.5	1.6	2,300	8.2	15	243	33	<0.040	0.001	1.000	0.07
	" R	"	64	23	6.70	77.2	0.3	230	8.4	20	204	21	0.050	<0.001	0.600	0.05
Platte River	P - 309.0	8:35 A May 11	-	14	8.38	80.9	1.5	24,000	8.4	25	173	-	-	-	-	-
3 1/2 miles southeast of North Platte at Diversion Dam	"	8:06 A May 13	-	15	7.69	75.7	1.7	24,000	8.4	30	174	-	-	-	-	-
	"	8:12 A May 18	-	17	7.58	77.8	1.3	4,300	8.4	40	179	-	-	-	-	-
	"	8:30 A May 20	-	14	8.32	80.4	1.5	7,500	8.4	35	172	14	-	-	-	-
	"	7:35 A May 25	-	15	8.12	80.0	1.7	2,300	8.4	30	172	11	-	-	-	-
	"	6:50 A May 27	-	17	6.59	67.7	2.4	24,000	7.9	75	170	4.4	-	-	-	-
	"	8:20 A June 1	-	17	7.59	78.0	2.0	9,300	8.2	30	166	14	-	-	-	-
	"	10:15 A June 3	-	16	8.72	87.7	1.6	9,300	8.0	55	163	9.2	-	-	-	-
	"	6:45 A June 10	-	18	7.27	76.3	1.2	24,000	8.4	50	170	13	-	-	-	-
	"	10:30 A June 24	-	22	5.75	65.3	1.8	15,000	7.9	320	171	24	0.140	<0.001	0.280	0.30
	"	8:40 A July 8	-	25	6.07	72.5	1.8	9,300	8.3	230	156	12	0.045	<0.001	0.200	0.12
South Platte River	P - 309.8 S.P. - 5.0	9:51 A May 3	164	15	8.73	86.0	1.2	930	8.3	25	189	24	-	-	-	-
Bridge - 1/2 mile south of North Platte, U. S. Highway #83	"	7:45 A May 11	260	14	8.70	81.9	2.5	230	8.4	20	202	-	-	-	-	-
	"	7:15 A May 13	227	14	8.44	81.4	1.8	930	8.4	30	203	-	-	-	-	-
	"	8:07 A May 20	204	14	8.80	84.9	1.3	930	8.4	15	213	24	-	-	-	-
	"	6:50 A May 25	244	13	8.79	82.9	2.0	230	8.4	25	208	24	-	-	-	-
	"	6:05 A May 27	240	16	7.77	78.2	1.6	430	8.2	35	197	39	-	-	-	-
	"	7:57 A June 1	188	16	8.49	85.3	0.9	230	8.2	25	197	25	-	-	-	-
	"	7:55 A June 3	176	15	8.69	85.6	1.1	930	8.3	20	196	26	-	-	-	-
	"	9:20 A June 8	209	15	9.23	90.9	0.7	430	8.4	20	211	24	-	-	-	-
	"	6:15 A June 10	184	17	8.27	84.9	0.8	230	8.5	25	205	23	-	-	-	-
	"	8:30 A June 24	13,100	21	6.11	68.1	1.7	4,300	7.9	350	173	26	0.140	<0.001	0.280	0.30
	"	8:15 A July 8	540	24	7.16	84.0	1.8	1,500	8.3	110	213	31	<0.040	<0.001	0.240	0.10
South Platte River	P - 309.8 S.P. - 48.7	6:40 A May 5	20	14	7.89	76.1	2.0	9,300	8.0	25	184	60	-	-	-	-
County Bridge - 1/4 mile south of Roscoe	"	6:10 A May 11	30	14	8.16	78.7	3.3	4,300	8.4	25	217	-	-	-	-	-
	"	5:50 A May 13	30	15	7.71	75.9	2.3	9,300	8.4	170	216	-	-	-	-	-
	"	5:20 A May 18	20	15	7.87	77.5	2.1	4,300	8.4	65	208	-	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO_4
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
South Platte River	P - 309.8 S.P. - 48.7	5:00 A May 20	20	13	8.47	79.9	2.9	24,000	8.4	55	205	57	-	-	-	-
County Bridge - 1/4 mile south of	"	4:45 A May 25	120	16	7.35	73.9	3.8	4,300	8.4	240	215	59	-	-	-	-
Roscoe	"	4:45 A May 27	115	18	6.75	70.8	3.0	2,300	8.2	100	197	56	-	-	-	-
	"	5:10 A June 1	40	16	7.42	74.7	3.4	9,300	8.2	250	203	52	-	-	-	-
	"	5:00 A June 3	20	16	7.72	77.6	2.3	24,000	8.3	140	226	58	-	-	-	-
	"	7:50 A June 8	30	15	8.77	86.4	2.3	110,000	8.4	190	224	61	-	-	-	-
	"	4:40 A June 10	600	18	6.90	72.4	2.6	46,000	8.1	550	173	39	-	-	-	-
	"	6:30 A June 23	-	21	6.16	68.5	1.6	9,300	7.9	400	162	25	0.140	0.002	0.280	0.30
	"	6:40 A July 8	150	23	6.70	77.1	1.2	9,300	8.4	800	221	45	<0.040	<0.001	0.600	0.15
North Platte River	P - 309.8 N.P. - 5.0	9:24 A May 5	328	15	8.64	85.1	0.9	2,300	8.3	35	149	9.1	-	-	-	-
Bridge - north edge of North Platte,	"	7:20 A May 11	448	14	8.81	85.0	1.5	4,300	8.3	25	192	-	-	-	-	-
U.S. Highway #83	"	6:55 A May 13	386	14	8.40	81.1	0.8	2,300	8.4	30	181	-	-	-	-	-
	"	7:45 A May 20	393	14	8.58	82.7	2.6	4,300	8.4	75	196	21	-	-	-	-
	"	6:36 A May 25	457	14	8.43	81.3	1.9	2,300	8.4	40	197	21	-	-	-	-
	"	5:40 A May 27	300	16	7.78	78.3	1.1	4,300	8.2	55	194	23	-	-	-	-
	"	7:39 A June 1	335	16	9.10	91.5	1.4	930	8.2	25	193	23	-	-	-	-
	"	7:45 A June 3	328	14	8.70	83.8	1.5	2,300	8.3	70	192	30	-	-	-	-
	"	9:00 A June 8	582	15	9.12	89.8	1.4	2,300	8.2	45	197	21	-	-	-	-
	"	6:05 A June 10	425	17	8.06	82.8	1.3	9,300	8.4	60	201	25	-	-	-	-
	"	8:10 A June 24	328	18	7.96	83.5	1.6	9,300	8.4	120	188	24	0.020	0.002	0.800	0.10
	"	7:45 A July 8	840	23	7.05	81.2	2.0	2,900	8.3	160	194	24	0.045	<0.001	1.000	0.10
North Platte River	P - 309.8 N.P. - 52.5	6:10 A May 5	14	14	8.02	77.4	1.1	2,300	7.9	35	144	2.4	-	-	-	-
County Bridge - 1/4 mile southwest	"	5:40 A May 11	23	12	8.06	74.4	1.4	230	7.9	15	145	-	-	-	-	-
of Keystone	"	5:25 A May 13	73	13	8.31	78.4	1.9	4,300	8.1	60	141	-	-	-	-	-
	"	5:00 A May 18	71	14	6.95	67.1	1.2	430	7.9	30	169	-	-	-	-	-
	"	4:44 A May 20	70	13	8.05	75.9	1.2	430	7.9	25	144	3.3	-	-	-	-
	"	5:10 A May 25	66	13	8.03	75.8	1.9	1,500	7.9	65	152	10	-	-	-	-
	"	4:25 A May 27	64	15	7.58	74.7	1.9	2,300	7.9	40	148	12	-	-	-	-
	"	4:40 A June 1	105	14	7.91	76.4	1.9	930	7.9	35	141	7.5	-	-	-	-
	"	7:00 A June 8	80	13	8.81	83.1	1.4	430	8.0	25	158	11	-	-	-	-
	"	4:20 A June 10	61	15	7.73	76.1	1.3	230	8.1	30	143	8.8	-	-	-	-
	"	6:10 A June 24	253	19	7.06	75.5	2.3	140	8.3	20	158	18	0.040	0.002	<0.020	0.08
	"	6:10 A July 8	763	22	6.63	75.1	2.8	230	7.8	75	164	18	0.120	<0.001	0.160	0.05
North Platte River	P - 309.8 N.P. - 84.8	10:25 A June 17	2,710	23	7.09	81.7	1.6	24,000	8.3	500	198	13	0.140	0.004	1.400	-
County Bridge - 1/2 mile south of	"	12:30 P June 22	2,780	26	7.73	94.0	2.5	-	8.4	450	189	13	0.050	0.001	0.800	-
Lewellen	"	1:52 P June 27	1,200	28	8.58	108.2	5.0	2,300	8.3	160	200	17	1.000	0.001	0.140	0.20

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO$_4$
					p.p.m.	% Sat.							NH$_3$	NO$_2$	NO$_3$	
Loup River	L - 0.2	11:21 A May 13	325	-	9.36	-	4.1	75,000	8.7	75	180	3.6	0.050	0.006	0.120	-
2 miles southeast of Columbus before	"	1:40 P May 17	308	22	8.07	91.5	5.1	75	8.5	1,000	174	6.9	0.160	0.004	-	-
confluence of the Platte and Loup	"	11:45 A May 25	1,271	20	8.41	91.7	3.8	43,000	8.3	800	125	<0.1	0.120	0.004	0.550	-
Rivers	"	2:03 P June 21	435	23	6.86	79.2	4.7	4,300	8.2	650	164	0.7	-	-	-	-
	"	11:52 A June 24	295	20	8.01	87.3	7.6	2,300	8.3	200	185	1.9	-	-	-	-
Loup River	L - 3.5 L	7:32 A Apr. 25	423	16	8.95	89.9	1.7	930	8.4	160	195	1.0	<0.040	0.002	0.500	-
Bridge - U. S. Highway #81, south	" R	"		16	9.00	90.5	1.6	750	8.4	150	201	0.7	<0.040	<0.001	-	-
of Columbus	" L	9:57 A Apr. 29	324	16	9.85	99.0	3.1	430	8.7	95	178	1.7	<0.040	0.001	0.070	-
	" R	"		16	10.16	102.0	2.7	430	8.7	70	182	1.3	<0.040	<0.001	0.070	-
	" L	1:22 P May 5	320	18	8.86	94.1	4.7	930	8.7	95	168	1.4	<0.040	<0.001	-	-
	" R	"		18	9.62	100.9	3.2	930	8.7	80	170	1.1	<0.040	<0.001	-	-
	" L	12:54 P May 10	612	20	9.22	100.1	4.4	2,300	8.7	90	148	1.2	-	-	-	-
	" R	"		20	9.52	104.1	3.6	1,500	8.7	75	144	1.0	-	-	-	-
	" L	9:55 A May 13	324	-	9.25	-	4.5	430	8.6	90	181	2.1	<0.040	0.004	0.150	-
	" R	"		-	9.14	-	2.7	930	8.7	65	180	0.7	<0.040	0.005	0.180	-
	" L	1:12 P May 17	307	21	8.44	93.9	3.5	15,000	8.5	1,000	179	2.0	<0.040	0.003	-	-
	" R	"		21	8.41	93.7	3.3	4,300	8.5	1,000	177	1.0	<0.040	0.006	-	-
	" L	11:02 A May 25	1,270	20	8.49	92.6	3.1	9,300	8.5	800	128	0.2	<0.040	0.006	0.350	-
	" R	"		20	8.48	92.4	3.1	15,000	8.4	800	128	0.7	<0.040	0.006	0.350	-
	" L	11:42 A June 7	961	18	8.84	92.7	2.9	43,000	8.5	290	179	0.6	<0.040	0.003	0.220	-
	" R	"		18	8.70	91.2	2.6	23,000	8.5	280	181	0.4	<0.040	0.003	0.220	-
	" L	8:58 A June 14	4,200	20	7.38	80.5	4.3	43,000	7.7	2,000	129	0.3	-	-	-	-
	" R	"		20	7.41	80.8	3.5	15,000	7.7	2,100	130	1.1	-	-	-	-
	" L	1:14 P June 21	434	22	7.10	80.4	3.6	4,300	8.3	500	162	0.1	-	-	-	-
	" R	"		22	7.04	79.6	3.7	43,000	8.2	600	163	1.0	-	-	-	-
	" L	12:27 P June 24	294	20	7.96	86.7	>8.0	4,300	8.3	210	194	1.2	-	-	-	-
Loup River	L - 17.7	8:24 A June 14	-	20	7.24	79.0	6.6	43,000	7.6	2,000	122	0.5	-	-	-	-
Bridge - South of Monroe																
Beaver Creek	L - 25.1 Be.C. - 2.6	11:00 A May 4	114	22	7.96	90.3	3.8	2,300	8.3	200	182	0.9	<0.040	0.009	0.130	-
Bridge - 1/2 mile west of Genoa	"	10:35 A May 10	135	15	9.16	90.2	3.6	9,300	8.3	170	188	1.0	-	-	-	-
	"	10:57 A May 17	129	18	8.24	86.5	3.9	9,300	8.4	250	183	0.1	<0.040	0.007	-	-
	"	10:28 A May 24	332	15	8.42	83.0	5.4	240,000	7.7	4,000	115	0.7	-	-	-	-
	"	1:19 P June 9	157	20	7.77	84.7	5.5	15,000	8.5	190	207	1.2	0.107	0.006	1.100	-
	"	12:09 P June 23	126	21	6.69	74.4	5.6	23,000	8.3	220	198	0.9	-	-	-	-
Beaver Creek	L - 25.1 Be.C. - 37.4	9:54 A May 10	130	16	8.30	83.4	3.9	75,000	7.8	140	127	0.1	0.170	0.010	0.200	-
County Bridge - 1 1/2 mile	"	9:58 A May 17	110	17	7.61	78.2	3.6	460,000	8.1	110	137	0.3	0.120	0.005	-	-
southeast of Albion	"	9:42 A May 24	340	14	7.70	74.3	4.6	43,000	7.7	260	116	0.3	-	-	-	-
Beaver Creek	L - 25.1 Be.C. - 42.4	10:06 A May 4	-	21	7.79	86.7	4.9	>110,000	8.2	60	139	< 0.1	0.170	0.003	0.040	-
Bridge - 1/2 mile east of Albion																

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO_4
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
Beaver Creek	L - 25.1 Be.C. - 42.9	9:52 A May 4	97	21	7.75	86.2	1.9	930	8.2	55	141	<0.1	0.040	0.001	0.040	-
Bridge - 1/2 mile northwest of Albion,	"	9:35 A May 10	130	16	8.54	85.8	2.6	4,300	7.9	110	129	0.2	0.080	0.009	0.300	-
Highway #14	"	9:23 A May 17	102	18	7.76	81.4	2.1	46,000	8.1	90	138	0.5	0.040	0.005	0.350	-
	"	9:11 A May 24	340	14	7.74	74.6	3.6	2,300	7.7	80	112	<0.1	-	-	-	-
	"	12:37 P June 9	225	19	7.01	75.0	4.1	4,300	8.4	180	126	1.5	0.220	0.008	1.250	-
	"	11:21 A June 23	100	20	6.54	71.3	>6.5	930	7.5	120	136	<0.1	-	-	-	-
Beaver Creek	L - 25.1 Be.C. - 50.6	9:26 A May 4	62	21	7.55	84.1	2.3	930	8.1	50	128	0.1	0.060	0.002	0.040	-
Bridge - 1/2 mile west of Loretto	"	8:30 A May 10	93	15	8.26	81.4	2.5	4,300	7.9	100	123	0.3	-	-	-	-
	"	8:57 A May 17	67	18	7.60	79.7	2.1	9,300	7.8	70	130	0.3	0.040	0.003	0.400	-
	"	8:46 A May 24	306	15	7.99	78.6	3.6	4,300	7.7	150	120	0.1	-	-	-	-
	"	12:16 P June 9	192	18	6.74	70.6	4.8	4,300	8.4	100	116	0.1	0.275	<0.001	0.600	-
	"	11:04 A June 23	63	19	6.73	71.3	2.3	930	7.5	70	131	0.4	-	-	-	-
Loup River	L - 26.9	11:50 A May 4	64	24	8.21	96.3	3.9	2,300	8.6	180	138	0.5	<0.040	<0.001	<0.020	-
Bridge - 1 1/2 miles south of	"	11:05 A May 10	246	15	9.18	90.4	2.2	2,300	8.4	160	134	0.9	-	-	-	-
Genoa, Highway #39	"	11:44 A May 17	100	18	8.89	93.2	3.0	2,300	8.7	70	160	0.7	<0.040	0.004	-	-
	"	11:37 A May 24	1,450	16	9.00	90.5	3.3	9,300	8.4	900	122	0.3	-	-	-	-
	"	12:25 P June 23	103	22	6.62	75.0	>6.6	4,300	7.5	450	134	1.7	-	-	-	-
Cedar River	L - 40.0 Ce.R. - 6.2	7:25 A May 10	241	14	8.99	86.6	1.8	9,300	8.3	160	155	0.4	<0.040	0.007	0.090	-
Bridge - 2 miles northwest of	"	7:17 A May 17	229	17	7.91	81.3	3.2	4,300	8.5	200	144	0.4	<0.040	0.003	0.030	-
Fullerton, Highway #14	"	7:29 A May 23	347	12	8.94	82.4	3.1	9,300	8.1	600	124	< 0.1	-	-	-	-
	"	1:58 P June 9	337	20	8.01	87.4	5.5	46,000	8.4	240	152	0.4	0.075	0.002	0.600	-
	"	7:34 A June 14	311	21	7.17	79.8	5.2	23,000	7.7	600	130	0.9	-	-	-	-
	"	1:02 P June 23	283	20	6.98	76.2	> 7.0	9,300	7.7	260	140	0.8	-	-	-	-
Cedar River	L - 40.0 Ce.R. - 11.0	7:53 A May 4	-	21	7.62	84.8	3.2	930	8.5	180	146	0.5	0.040	<0.001	0.030	-
Bridge - 6 miles northwest of																
Fullerton, Highway #52																
Loup River	L - 42.5	7:26 A May 4	1,950	20	7.72	84.2	2.7	230	8.5	120	125	0.4	0.040	<0.001	0.020	-
Bridge - 1/2 mile south of Fullerton	"	7:00 A May 10	2,540	14	8.85	85.4	2.5	2,300	8.3	140	136	0.2	0.040	0.008	0.160	-
	"	6:41 A May 17	2,110	17	7.90	81.2	3.6	430	8.8	110	136	0.7	0.040	<0.001	0.030	-
	"	7:10 A May 24	2,940	12	9.16	84.5	3.0	24,000	8.3	550	120	0.6	-	-	-	-
	"	2:19 P June 9	8,580	19	7.32	78.3	4.3	43,000	8.4	3,000	104	0.4	0.050	0.002	0.800	-
	"	7:06 A June 14	3,380	19	7.16	76.6	5.7	43,000	7.7	1,400	118	1.6	-	-	-	-
	"	1:24 P June 23	1,850	23	6.61	76.2	3.2	9,300	7.5	380	134	2.4	-	-	-	-
Spring Creek	L - 66.5 Sp.C. - 0.7	1:50 P May 2	8.3	22	11.11	126.0	4.7	1,500	8.4	20	307	4.2	-	-	-	-
Bridge - 6 miles northeast of	"	2:00 P May 9	8.0	18	10.42	109.5	2.2	24,000	8.3	90	317	6.4	-	-	-	-
St. Paul, State Highway #96	"	1:05 P May 23	7.0	15	8.70	85.6	6.6	110,000	7.9	800	204	2.7	0.500	0.020	1.400	-
	"	9:00 A May 24	7.0	12	9.38	86.5	5.2	93,000	8.0	550	262	4.6	0.400	0.060	1.400	-
	"	12:00 N June 6	7.0	20	8.02	87.4	8.0	24,000	8.2	130	345	4.8	-	-	-	-
	"	10:40 A June 20	7.0	21	6.96	77.5	2.0	24,000	8.5	130	331	4.7	0.140	0.007	1.400	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1969	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO$_4$
					p.p.m.	% Sat.							NH$_3$	NO$_2$	NO$_3$	
North Loup River	L - 67.5 N.L. - 3.5	1:10 P May 2	1,020	20	9.78	106.7	4.5	750	7.9	90	110	0.2	-	-	-	-
Bridge - 3 miles north of St. Paul	"	10:38 A May 6	840	14	9.51	91.8	4.8	930	7.9	100	110	1.3	-	-	-	-
U.S.Highway #281	"	1:35 P May 9	1,310	18	9.44	99.0	2.8	2,300	7.9	95	170	1.6	-	-	-	-
	"	10:55 A May 16	946	20	8.94	97.4	5.1	930	8.1	80	117	-	<0.040	0.001	0.160	-
	"	12:40 P May 23	1,010	15	8.68	85.5	3.5	9,300	7.9	450	109	1.2	<0.040	0.002	0.320	-
	"	9:25 A May 24	1,360	15	9.29	91.5	3.0	9,300	7.9	200	115	< 0.1	0.040	0.001	0.240	-
	"	11:50 A June 6	886	24	8.89	104.5	4.3	210	8.4	120	111	0.8	-	-	-	-
	"	11:00 A June 7	1,340	17	6.62	67.9	5.2	24,000	7.6	1,400	143	< 0.1	-	-	-	-
	"	9:54 A June 13	1,480	20	5.67	62.1	4.6	4,300	7.7	700	151	0.5	0.100	<0.001	0.200	-
	"	10:18 A June 20	972	24	7.66	89.8	6.0	4,300	7.9	200	140	0.7	0.140	<0.001	0.600	-
Davis Creek	L - 67.5 N.L. - 21.0	11:56 A May 12	3	22	11.13	126.2	3.5	24,000	8.4	30	301	-	0.040	0.001	0.200	-
County Bridge- 5 miles south of	Da.C. - 1.5 "	11:20 A May 19	3	15	10.71	105.8	2.4	2,100	8.4	40	316	7.2	-	-	-	-
Scotia	"	10:52 A May 26	2.2	20	9.94	108.2	3.1	4,300	8.4	25	301	5.2	-	-	-	-
	"	9:40 A June 2	2.3	19	8.21	87.8	3.0	9,300	8.2	25	312	4.1	-	-	-	-
	"	10:15 A June 16	2.5	22	6.99	79.2	3.4	9,300	8.0	560	200	2.6	-	-	-	-
North Loup River	L - 67.5 N.L. - 25.8	9:44 A May 6	1,110	14	9.42	90.9	2.2	7,500	7.8	85	106	1.1	-	-	-	-
Railroad Bridge 1 mile southwest	"	11:25 A May 12	856	20	8.69	94.7	2.1	2,300	8.4	30	115	-	-	-	-	-
of Scotia	"	10:55 A May 19	867	15	9.47	93.2	3.4	4,300	8.1	55	116	1.9	-	-	-	-
	"	10:35 A May 26	996	20	8.85	96.4	3.3	430	8.2	60	108	0.6	-	-	-	-
	"	10:05 A June 2	924	20	9.89	107.8	>9.9	2,300	8.4	95	110	0.9	-	-	-	-
	"	10:40 A June 16	1,070	22	8.51	96.8	7.3	9,300	3.1	160	108	1.1	-	-	-	-
North Loup River	L - 67.5 N.L. - 42.2	8:05 A May 3	930	18	8.83	92.6	2.2	9,300	7.9	50	93	0.5	-	-	-	-
2 miles southeast of Ord where State	"	10:58 A May 12	730	20	8.83	96.3	2.5	9,300	7.9	25	107	-	0.040	0.001	0.320	-
Highway #11 parallels river -	"	10:10 A May 19	750	15	9.34	92.0	3.2	4,300	8.1	55	105	1.6	-	-	-	-
no bridge	"	10:07 A May 26	970	19	8.63	92.3	2.3	7,500	8.0	30	109	0.6	-	-	-	-
	"	10:30 A June 2	780	20	9.55	104.1	>9.5	2,300	8.3	75	106	0.3	-	-	-	-
	"	11:20 A June 16	870	22	8.48	96.1	5.6	2,300	8.2	110	108	0.7	-	-	-	-
North Loup River	L - 67.5 N.L. - 44.8	8:40 A May 3	950	17	8.88	91.2	4.7	930	7.9	70	97	1.4	-	-	-	-
Bridge at Ord - State Highway #58	"	10:28 A May 12	800	20	8.68	94.7	1.8	4,300	7.9	30	105	-	-	-	-	-
	"	9:50 A May 19	800	15	9.08	89.5	4.0	1,500	8.1	65	105	1.3	-	-	-	-
	"	9:52 A May 26	1,050	18	8.49	89.0	2.4	2,300	8.1	30	108	0.7	-	-	-	-
	"	10:50 A June 2	900	21	9.97	110.8	>10.0	2,300	8.4	30	105	0.1	-	-	-	-
	"	10:50 A June 9	-	19	8.92	95.4	4.4	4,300	7.9	120	104	0.6	0.060	<0.001	0.600	<0.005
	"	11:40 A June 16	940	22	8.33	94.4	5.2	2,100	8.4	100	104	0.8	-	-	-	-
Calamus River	L - 67.5 N.L. - 65.7	10:10 A May 3	295	19	9.12	97.6	1.5	430	7.7	25	76	0.8	-	-	-	-
County Bridge - 2 1/2 miles	Ca.R.- 1.7 "	6:50 A May 12	279	15	8.42	83.0	1.1	2,300	7.7	25	76	-	0.060	0.001	0.400	-
Northwest of Burwell	"	6:40 A May 19	243	12	8.85	81.6	1.5	91	7.7	25	76	0.9	-	-	-	-
	"	7:20 A May 26	350	16	8.45	85.0	0.8	430	7.7	30	81	0.4	-	-	-	-
	"	11:30 A June 2	322	22	9.40	106.4	>9.4	930	8.4	75	108	0.1	-	-	-	-
	"	11:30 A June 9	400	21	8.45	94.0	4.8	24,000	7.9	160	100	< 0.1	0.060	<0.001	0.400	<0.005
	"	12:45 P June 16	365	24	8.13	95.4	2.0	430	7.8	45	86	0.8	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D.	Coliforms M.P.N.	pH	Turb.	Alkal.	Cl.	Nitrogen - N p.p.m.			PO_4
					p.p.m.	% Sat.	p.p.m.	Per 100 ml		p.p.m.	p.p.m.	p.p.m.	NH_3	NO_2	NO_3	
North Loup River	L - 67.5 N.L. - 67.2	9:45 A May 3	512	18	8.71	91.3	3.0	150	7.8	50	95	1.4	-	-	-	-
County Bridge - 3/4 mile west of	"	6:20 A May 12	485	17	8.50	87.3	1.8	4,300	7.9	110	102	-	0.040	0.001	0.600	-
Burwell	"	6:20 A May 19	528	13	8.61	81.2	4.4	73	7.9	40	105	1.2	-	-	-	-
	"	6:58 A May 26	597	17	8.37	86.1	2.6	210	7.9	35	108	0.9	-	-	-	-
	"	12:10 P June 2	572	22	8.30	94.0	1.9	4,300	8.0	95	80	0.2	-	-	-	-
	"	11:45 A June 9	710	20	8.56	93.4	1.0	3,900	7.6	35	80	0.8	0.040	<0.001	0.040	<0.005
	"	12:30 P June 16	480	25	8.46	100.1	6.7	930	8.6	90	106	1.4	-	-	-	-
North Loup River	L - 67.5 N.L. - 77.8	11:30 A May 3	488	20	8.61	93.9	2.0	36	7.8	40	85	1.1	-	-	-	-
Bridge - 1/2 mile north of Taylor,	"	8:11 A May 12	462	16	8.59	86.3	1.1	150	7.9	25	103	-	0.060	0.001	0.400	-
U.S. Highway #183	"	7:40 A May 19	516	13	8.64	81.6	3.4	430	7.9	35	99	1.2	-	-	-	-
	"	8:04 A May 26	580	17	8.40	86.4	2.0	30	7.9	25	104	0.9	-	-	-	-
	"	12:45 P June 2	550	22	9.26	104.8	8.8	390	8.4	60	91	0.8	-	-	-	-
	"	1:00 P June 9	650	21	8.81	97.8	3.6	930	7.9	65	90	1.2	0.050	<0.001	0.400	<0.005
	"	1:15 P June 16	426	25	8.10	96.6	5.2	91	8.6	70	97	0.9	-	-	-	-
North Loup River	L - 67.5 N.L. - 111.6	7:40 A May 4	425	18	8.06	84.6	1.6	230	7.9	45	91	0.4	8.27	-	-	-
Bridge - 1/2 mile north of Brewster	"	7:25 A May 10	434	13	10.16	95.8	1.8	230	7.7	45	90	-	0.040	0.001	0.600	-
	"	7:40 A May 17	460	16	8.47	85.2	2.6	230	7.9	35	93	-	0.070	0.001	-	-
	"	12:00 N June 14	585	19	8.65	92.5	4.5	430	7.9	70	99	1.2	-	-	-	-
Middle Loup River	L - 67.5 M.L. - 6.6	2:15 P May 2	1,020	22	8.68	98.3	2.5	230	8.0	130	135	0.6	-	-	-	-
Bridge - 1/2 mile southeast of	"	11:55 A May 6	1,490	15	9.07	89.4	4.3	930	8.2	240	130	1.9	-	-	-	-
St. Paul, U.S. Highway #281	"	1:10 P May 9	1,510	17	9.20	94.5	2.7	9,300	8.4	180	141	2.4	-	-	-	-
	"	11:25 A May 16	1,020	20	8.96	97.8	2.9	930	8.4	90	140	-	0.040	0.001	0.160	-
	"	12:00 N May 23	1,880	15	8.85	87.1	2.7	9,300	7.9	350	127	1.8	0.040	0.003	0.400	-
	"	10:05 A May 24	1,440	15	9.23	91.0	2.5	4,300	8.0	290	136	1.2	0.040	0.002	0.400	-
	"	11:30 A June 6	2,030	23	8.33	95.9	3.4	4,300	8.3	330	136	0.1	-	-	-	-
	"	11:20 A June 7	7,250	16	7.20	72.4	4.9	>110,000	7.6	5,200	100	1.5	-	-	-	-
	"	10:15 A June 13	1,370	20	7.84	85.5	3.6	15,000	8.0	650	137	1.6	0.100	0.001	0.320	-
	"	10:00 A June 20	1,120	24	7.04	82.5	3.2	4,300	8.1	550	144	0.9	0.320	0.017	0.320	-
South Loup River	L - 67.5 M.L.- 25.2	9:35 A May 2	235	15	9.43	92.9	3.8	23,000	8.0	450	216	3.8	-	-	-	-
Bridge - 2 miles east of Ravenna	S.L.- 16.0 "	4:10 P May 9	300	19	8.05	86.1	3.9	43,000	8.0	290	209	4.3	-	-	-	-
	"	2:10 P June 6	304	26	7.25	88.2	2.1	9,300	8.3	300	206	0.5	-	-	-	-
	"	1:15 P June 13	663	22	7.02	79.5	3.9	110,000	8.0	3,400	171	2.4	0.140	0.003	0.800	-
	"	1:00 P June 20	275	27	6.95	86.1	3.4	9,300	8.2	590	199	2.5	0.140	0.003	1.400	-
Mud Creek	L - 67.5 M.L.- 25.2	2:40 P June 6	36	23	7.34	84.5	2.6	1,500	8.3	280	301	5.1	-	-	-	-
County Bridge - 5 miles northwest	S.L.- 18.0 Mu.C-12.8	2:07 P June 13	85	21	6.57	73.1	3.5	24,000	8.0	1,400	249	6.4	0.160	0.040	1.200	-
of Ravenna	"	1:50 P June 20	46	22	6.62	75.0	3.0	46,000	7.9	1,800	240	5.3	0.180	<0.001	2.000	-
Mud Creek	L - 67.5 M.L.- 25.2	10:55 A May 4	-	22	13.72	155.6	13.1	15,000	8.6	10	316	25	-	-	-	-
Bridge - 2 miles southeast of	S.L. -18.0 Mu.C.-67.6	10:00 A May 10	2	15	9.48	93.4	8.0	9,300	7.9	30	260	-	-	-	-	-
Broken Bow	"	9:55 A May 17	2	17	7.40	75.9	7.7	2,300	7.9	15	311	-	2.000	0.500	1.400	-
	"	2:10 P June 14	12	21	4.84	53.8	12.6	>110,000	7.5	320	246	23	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO_4
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
Mud Creek	L - 67.5 M.L. - 25.2	10:20 A May 4	-	18	7.67	80.4	18.9	4,300	7.3	110	133	2.8	-	-	-	-
Bridge - 1 mile west of Broken Bow,	S.L.- 18.0 Mu.C.- 73.0	9:33 A May 10	-	14	5.59	53.9	6.4	24,000	7.3	40	133	-	0.500	0.001	0.280	-
State Highway #2	"	1:30 P June 14	-	19	0.76	8.1	10.3	46,000	7.4	180	109	3.0	-	-	-	-
South Loup River	L - 67.5 M.L. - 25.2	9:00 A May 2	195	14	9.81	94.7	3.2	430	8.1	400	204	3.8	-	-	-	-
Bridge - 1 mile south of Ravenna,	S.L. - 19.0 "	4:30 P May 9	256	20	8.03	87.6	3.4	4,300	8.2	340	195	3.7	-	-	-	-
Old State Highway #2	"	2:20 P June 6	268	26	7.48	91.0	4.2	930	8.3	340	182	0.7	-	-	-	-
	"	1:40 P June 13	585	23	7.11	81.9	5.1	110,000	7.9	4,400	144	1.0	0.140	0.003	0.800	-
	"	1:20 P June 20	226	29	6.81	87.7	3.6	24,000	8.4	500	189	1.5	0.140	<0.001	1.400	-
Middle Loup River	L - 67.5 M.L. - 42.9	11:00 A May 2	790	15	9.58	94.4	2.1	360	7.9	100	112	0.4	-	-	-	-
6 miles south of Loup City - County	"	3:30 P May 9	700	19	8.83	94.6	1.7	2,300	7.9	100	112	0.6	-	-	-	-
road west of State Highway #58 at	"	2:30 P May 23	800	15	9.10	89.6	2.0	12,000	7.9	140	105	0.5	<0.040	0.003	0.400	-
Austin - no bridge	"	1:35 P June 6	814	26	8.36	101.7	2.7	4,300	8.3	75	110	0.1	-	-	-	-
	"	12:20 P June 20	752	27	8.00	99.1	4.0	430	8.4	75	113	0.9	0.110	0.002	0.120	-
Middle Loup River	L - 67.5 M.L. - 51.1	11:40 A May 2	790	18	9.50	99.6	2.0	930	7.9	100	105	1.8	-	-	-	-
Bridge - 1 mile west of Loup City	"	3:00 P May 9	700	19	8.69	92.9	1.6	430	7.9	110	104	1.3	-	-	-	-
Highway #92	"	2:00 P May 23	800	15	9.13	89.9	1.8	4,300	7.9	140	104	0.5	<0.040	0.002	0.400	-
	"	1:10 P June 6	814	25	8.19	97.6	2.4	390	8.3	75	107	0.2	-	-	-	-
	"	11:25 A June 13	1,120	22	8.19	92.7	3.2	24,000	8.1	180	108	0.6	0.120	0.001	0.200	-
	"	11:40 A June 20	752	26	8.06	98.1	3.6	2,300	8.5	90	112	0.9	0.140	0.002	0.280	-
Middle Loup River	L - 67.5 M.L. - 97.3	12:30 P May 3	1,060	24	8.21	96.3	1.4	2,300	7.9	160	98	1.2	-	-	-	-
County Bridge at Walworth	"	9:03 A May 12	822	17	8.51	87.5	1.0	430	7.9	125	100	-	-	-	-	-
	"	8:20 A May 19	804	14	9.15	88.3	1.1	230	8.0	45	96	1.0	-	-	-	-
	"	8:45 A May 26	1,060	18	8.49	89.0	0.9	930	8.0	50	103	0.4	-	-	-	-
	"	1:25 P June 2	975	23	7.89	91.0	1.8	430	8.3	65	94	0.3	-	-	-	-
	"	3:00 P June 16	778	27	7.71	95.5	1.6	230	8.2	85	97	0.9	-	-	-	-
Dismal River	L - 67.5 M.L.- 129.7	9:05 A May 4	303	18	8.41	88.2	1.3	430	7.8	95	68	1.1	-	-	-	-
Bridge - 1/4 mile south of Dunning,	Di.R.- 1.4 "	8:40 A May 10	324	14	9.52	91.9	1.2	430	7.7	75	84	-	<0.040	0.001	0.400	-
State Highway #2	"	8:40 A May 17	330	17	8.58	88.1	1.4	930	7.9	60	85	-	0.030	0.001	0.600	-
	"	12:45 P June 14	342	20	8.42	91.8	1.4	2,300	7.9	85	96	1.0	-	-	-	-
Middle Loup River	L - 67.5 M.L. - 131.3	8:45 A May 4	424	18	8.24	86.3	1.8	2,300	7.9	100	124	1.0	-	-	-	-
Bridge - 1/4 mile north of Dunning,	"	8:10 A May 10	350	14	8.01	77.4	0.1	4,300	7.9	45	98	-	0.010	<0.001	0.600	-
State Highway #2	"	8:25 A May 17	424	17	8.55	87.8	1.3	2,300	7.9	35	99	-	0.050	0.001	0.800	-
	"	12:30 P June 14	424	20	8.52	92.9	1.6	2,300	7.9	210	114	0.3	-	-	-	-
Middle Loup River	L - 67.5 M.L. - 182.1	5:45 A May 4	245	16	7.62	76.6	1.1	230	7.9	85	135	1.1	-	-	-	-
1/4 mile northeast of Kelso (Mullen) -	"	5:25 A May 10	239	13	8.42	79.4	0.8	93	7.9	40	116	-	0.020	0.001	0.400	-
no bridge	"	5:40 A May 17	248	15	8.03	79.1	0.9	2,400	7.9	45	111	-	0.040	0.001	0.800	
	"	10:40 A June 14	233	15	8.49	83.6	1.1	1,500	7.9	85	132	1.3	-	-	-	-
Middle Loup River Bridge - 1 3/4 miles																
north of Mullen, U.S. Highway #83	L - 67.5 M.L. - 188.6	10:10 A June 14	233	15	7.96	78.5	1.1	2,300	7.8	75	128	1.8	-	-	-	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
Elkhorn River	E - 10.0	1:40 P Apr. 28	2,000	19	8.30	102.1	5.4	110,000	8.3	1,100	196	4.9	0.090	0.005	0.300	-
Bridge - 1 1/2 miles southeast of Elkhorn																
Highway #30																
Elkhorn River	E - 15.0	7:57 A May 5	1,650	20	7.40	81.1	4.5	43,000	8.4	180	206	6.8	<0.040	0.006	0.450	-
Bridge - 1 3/4 miles northeast of Valley	"	9:44 A May 11	1,372	18	8.47	88.8	4.0	43,000	8.6	200	207	7.9	0.050	0.035	0.800	-
	"	9:36 A May 19	1,680	15	7.20	70.8	6.0	750,000	7.9	2,400	192	3.2	-	-	-	-
	"	8:27 A May 27	3,330	17	7.32	75.2	2.6	230,000	7.8	1,200	163	1.8	-	-	-	-
	"	9:59 A June 2	2,510	17	5.41	55.6	4.6	430,000	7.6	11,200	168	2.2	0.060	0.015	0.800	-
	"	8:34 A June 10	1,930	19	7.59	81.2	5.3	43,000	8.3	450	216	3.4	0.090	0.012	1.640	-
	"	9:24 A June 17	1,940	20	7.17	78.2	3.6	93,000	8.3	2,100	174	2.1	-	-	-	-
	"	8:03 A June 24	1,860	22	6.44	72.9	5.8	24,000	7.7	3,600	177	2.6	-	-	-	-
	"	1:48 A June 28	1,270	23	6.18	71.2	4.8	93,000	8.3	800	188	3.7	0.650	0.001	0.085	-
Elkhorn River	E - 20.1	1:21 P Apr. 27	2,100	18	8.40	88.1	2.6	24,000	8.3	330	202	4.6	0.080	0.005	0.400	-
Bridge - 8 miles east and 2 miles	"	7:33 A May 5	1,650	21	7.50	84.5	3.3	43,000	8.4	210	210	5.0	0.120	0.003	0.090	-
south of Fremont, Highway #8	"	9:22 A May 11	1,370	18	8.51	89.4	5.0	43,000	8.6	280	220	4.8	0.060	0.011	0.500	-
	"	9:05 A May 19	1,680	16	7.00	70.4	5.5	93,000	7.9	1,900	201	3.6	-	-	-	-
	"	7:39 A May 27	3,330	18	7.41	77.8	2.5	43,000	7.8	1,300	155	1.7	-	-	-	-
	"	9:26 A June 2	2,510	16	5.19	52.1	3.8	460,000	7.4	19,000	164	1.8	0.190	0.025	1.750	-
	"	8:07 A June 10	1,930	18	7.59	79.6	5.4	23,000	8.4	400	213	3.8	0.110	0.013	0.400	-
	"	8:51 A June 17	1,940	19	6.95	74.4	4.4	430,000	8.3	1,500	172	2.7	-	-	-	-
	"	7:17 A June 24	1,860	21	6.20	69.0	4.9	23,000	7.9	3,000	177	1.9	-	-	-	-
	"	1:23 P June 28	1,270	21	6.39	71.1	8.0	43,000	8.3	1,000	193	4.3	0.500	0.001	0.130	-
Logan Creek	E - 43.8 Lo.C. - 10.0	6:24 A June 24	140	21	6.78	75.4	5.6	240,000	8.2	450	281	3.7	-	-	-	-
	"	12:43 P June 28	140	20	6.06	66.1	3.7	93,000	8.2	,400	212	3.1	-	-	-	-
South Fork Logan Creek	E - 43.8 Lo.C. - 60.0	5:04 A May 11	-	17	3.67	37.7	5.7	910	7.9	25	310	7.4	0.630	0.325	3.200	-
County Bridge - 1 mile north and	S.F.Lo.C. - 6.6	5:51 A May 18	-	16	4.71	47.4	5.2	43,000	8.3	85	293	8.3	0.850	0.150	1.700	-
2 miles east of Wayne	"	6:20 A May 25	-	14	8.35	80.5	2.8	75,000	8.4	340	356	5.1	0.355	0.080	3.950	-
	"	5:18 A June 7	-	18	6.82	71.5	3.2	150,000	8.4	140	352	5.9	0.380	0.220	7.000	-
	"	5:23 A June 17	-	19	5.70	60.9	>5.7	230,000	8.3	85	343	6.8	-	-	-	-
	"	6:29 A June 21	-	18	7.56	79.2	7.1	430,000	8.3	100	332	5.9	0.165	0.164	5.950	-
	"	9:46 A June 28	-	19	7.13	76.3	6.4	230,000	8.4	310	251	5.8	4.500	0.150	0.375	-
South Fork Logan Creek	E - 43.8 Lo.C. - 60.0	7:53 A April 27	-	14	6.34	61.1	4.2	46,000	7.9	7	214	6.2	0.380	0.350	2.700	-
County Bridge - 1 mile east of	S.F.Lo.C. - 7.3	6:25 A May 2	-	10	5.97	52.7	3.4	46,000	8.1	55	273	8.2	0.600	0.300	4.500	-
Wayne																
South Fork Logan Creek	E - 43.8 Lo.C. - 60.0	7:35 A April 27	-	13	10.04	94.7	3.0	930	8.4	11	234	5.9	<0.040	0.300	3.300	-
Bridge South of Wayne - Highways	S.F.Lo.C. - 9.6	6:45 A May 2	-	10	10.08	88.9	2.8	910	8.3	50	267	5.9	<0.040	0.250	4.800	-
#15 and #35	"	7:31 A May 11	-	17	7.45	76.5	2.3	110,000	8.2	25	283	5.9	0.070	0.125	5.400	-
	"	6:22 A May 18	-	16	8.13	81.6	5.0	110,000	8.3	480	272	4.7	0.250	0.110	3.200	-
	"	6:46 A May 25	-	15	8.74	86.1	1.8	43,000	8.4	330	363	5.6	0.310	0.095	4.500	-
	"	5:48 A June 2	-	17	7.12	73.2	4.9	230,000	7.3	11,000	97	0.5	0.240	0.030	0.750	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO_4
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
South Fork Logan Creek	E - 43.8 Lo.C. - 60.0	5:40 A June 7	-	17	8.13	83.5	2.0	4,300	8.4	150	345	5.5	0.250	0.180	10.000	-
Bridge South of Wayne - Highways	S.F.Lo.C. - 9.6	5:49 A June 17	-	19	7.34	78.5	4.8	9,300	8.4	170	342	5.8	-	-	-	-
#15 and #35	"	6:58 A June 21	-	19	7.70	82.4	7.2	9,300	8.3	95	336	5.7	0.160	0.165	2.750	-
	"	10:12 A June 28	-	19	6.10	65.2	7.0	46,000	8.3	450	245	4.9	5.000	0.155	0.375	-
Deer Creek County Bridge - 1/2	E - 43.8 Lo.C. - 60.0	7:18 A May 2	-	10	9.95	87.7	2.1	930	8.3	35	256	5.7	<0.040	0.150	4.400	-
mile southwest of Wayne	S.F.Lo.C. - 10.3															
	Tr.Cr. -0.7															
South Fork Logan Creek	E - 43.8 Lo.C. - 60.0	7:08 A May 2	-	10	9.96	87.8	2.9	24,000	8.3	15	287	7.9	0.040	0.300	5.100	-
County Bridge about 1 mile southwest of	S.F.Lo.C. - 10.5															
Wayne																
Elkhorn River	E - 46.2	11:17 A Apr. 27	1,500	17	8.09	83.1	3.2	24,000	8.1	600	191	4.1	0.060	0.006	0.450	-
Bridge - 1 mile north of Hooper	"	6:22 A May 5	1,100	21	7.15	82.6	4.0	2,100	8.3	180	206	2.3	0.060	0.002	0.080	-
	"	8:23 A May 11	950	19	6.59	91.9	4.0	23,000	8.7	200	204	3.0	0.040	0.007	0.400	-
	"	8:03 A May 19	1,200	15	7.17	70.6	5.5	3,600	7.8	3,500	161	2.2	-	-	-	-
	"	6:41 A May 27	3,000	17	7.29	74.9	2.9	21,000	7.8	1,100	139	0.4	-	-	-	-
	"	8:11 A June 2	7,000	16	5.64	56.6	4.0	460,000	7.4	11,800	146	0.3	0.150	0.015	0.800	-
	"	7:23 A June 10	1,800	20	7.55	82.3	6.2	43,000	8.4	320	204	1.1	0.095	0.013	0.600	-
	"	8:06 A June 17	1,800	19	7.05	75.4	5.0	75,000	7.9	1,000	104	1.4	-	-	-	-
	"	5:44 A June 24	1,600	23	6.45	74.3	4.7	23,000	7.6	4,100	156	0.5	-	-	-	-
	"	12:18 P June 28	1,200	23	6.79	78.2	6.9	9,300	8.4	400	208	3.8	0.090	<0.001	0.050	-
Elkhorn River	E - 62.0	5:42 A May 5	-	20	7.34	80.1	6.7	21,000	8.3	150	201	3.1	0.060	0.001	0.070	-
Bridge - 8 miles south of West Point,																
Highway #275																
Elkhorn River	E - 72.5	7:20 A May 11	950	18	8.26	86.6	4.4	23,000	8.7	120	204	2.8	<0.040	0.008	0.350	-
1 1/2 miles south of West Point on a	"	7:15 A May 19	1,200	15	7.79	76.7	6.2	240,000	7.8	5,500	161	2.1	0.120	0.014	1.550	-
dead end County Road	"	6:48 A June 10	1,600	19	7.62	81.5	7.2	43,000	8.4	340	204	1.1	0.065	0.009	0.500	-
	"	7:22 A June 17	1,800	18	6.60	69.2	5.6	93,000	7.9	900	175	1.1	-	-	-	-
	"	4:51 A June 24	1,600	22	6.25	70.7	5.0	93,000	7.7	3,700	175	0.9	-	-	-	-
	"	11:29 A June 28	1,200	21	6.51	72.5	7.5	2,100	8.3	400	204	1.8	0.165	<0.001	0.045	-
Elkhorn River	E - 75.5	10:38 A Apr. 27	-	17	8.46	87.0	8.5	9,300	8.1	290	193	4.1	0.060	0.009	0.350	-
Bridge at West Point	"	5:14 A May 5	-	21	7.10	79.0	4.2	930	8.3	160	199	4.0	<0.040	<0.001	0.050	-
	"	6:51 A May 11	-	18	8.40	88.1	4.5	2,300	8.7	160	210	2.6	<0.040	0.007	0.320	-
	"	6:53 A May 19	-	15	7.60	74.8	5.6	>110,000	7.8	4,900	152	1.6	0.120	0.014	1.500	-
	"	5:36 A May 27	-	17	7.39	75.9	2.7	43,000	7.8	1,200	161	2.4	-	-	-	-
	"	7:31 A June 2	-	16	6.27	63.0	4.6	230,000	7.5	11,500	109	<0.1	0.190	0.013	0.650	-
	"	6:27 A June 10	-	19	7.63	81.6	4.2	24,000	8.3	300	210	0.9	0.055	0.011	1.500	-
	"	6:58 A June 17	-	19	6.66	71.3	5.0	43,000	8.1	650	175	1.5	-	-	-	-
	"	5:16 A June 24	-	22	6.75	76.4	6.0	240,000	7.7	4,000	171	1.0	-	-	-	-
	"	11:10 A June 28	-	21	6.79	75.5	6.1	3,900	7.7	390	192	3.0	0.165	<0.001	0.050	-
Elkhorn River	E - 98.3	9:11 A Apr. 27	-	16	8.29	83.3	2.3	4,300	8.3	200	186	2.8	0.050	0.008	0.400	-
Bridge south of Wisner	"	8:40 A May 2	-	14	9.25	89.2	0.4	4,300	8.4	140	189	2.2	0.080	<0.001	0.250	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO_4
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
Elkhorn River	E - 98.3	6:16A May 11	-	18	8.17	85.8	4.6	4,300	8.6	90	198	2.6	<0.040	0.007	0.220	-
Bridge south of Wisner	"	7:05 A May 18	-	18	7.59	79.5	5.4	24,000	8.7	450	190	2.5	<0.040	0.006	0.080	-
	"	7:29 A May 25	-	17	7.32	75.2	3.2	15,000	7.7	1,000	120	0.5	-	-	-	-
	"	6:43 A June 7	-	19	6.87	73.5	2.5	9,300	8.1	320	196	0.6	0.175	0.011	1.300	-
	"	6:27 A June 17	-	20	6.52	71.1	5.1	23,000	8.1	450	174	0.4	-	-	-	-
	"	7:44 A June 21	-	21	6.71	74.6	11.9	93,000	8.6	1,300	193	1.3	0.145	0.011	0.350	-
	"	10:43 A June 28	-	21	6.60	73.4	6.2	9,300	8.4	230	204	1.3	0.250	<0.001	0.050	-
Elkhorn River	E - 122.0	2:23 P Apr. 26	1,300	19	8.05	86.1	2.1	9,300	8.3	180	188	2.9	0.040	0.006	0.300	-
Bridge - 1/2 mile north and 3 1/2 miles east of Stanton	"	9:20 A May 2	900	15	9.06	89.3	2.8	9,300	8.4	100	190	2.1	0.040	0.001	0.180	-
	"	9:32 A May 12	780	20	8.60	93.7	4.2	9,300	8.4	100	190	3.2	-	-	-	-
	"	8:23 A May 18	700	17	6.94	71.2	5.8	93,000	7.7	3,900	150	1.1	0.090	0.013	0.400	-
	"	8:26 A May 25	2,300	17	7.77	79.8	3.3	23,000	7.7	650	124	1.3	-	-	-	-
	"	7:26 A June 7	-	19	6.80	72.7	2.6	43,000	8.1	260	186	0.4	-	-	-	-
	"	2:31 P June 16	1,300	21	7.03	78.3	5.4	43,000	7.8	400	164	1.8	-	-	-	-
	"	8:30 A June 21	850	21	6.92	77.0	12.4	43,000	8.7	1,100	192	0.2	0.120	0.013	0.310	-
	"	9:08 A June 28	600	21	6.76	75.3	5.7	93,000	7.9	290	197	2.3	0.080	0.001	0.045	-
Elkhorn River	E - 127.2	2:48 P Apr. 26	1,150	19	8.12	86.8	2.4	9,300	8.2	170	182	2.5	<0.040	0.004	0.400	-
Bridge south of Stanton	"	9:45 A May 2	900	14	9.25	89.2	4.9	9,300	8.4	100	190	2.9	0.060	<0.001	0.200	-
	"	10:30 A May 12	700	20	9.36	102.0	4.9	9,300	8.5	70	192	2.8	-	-	-	-
	"	9:03 A May 18	696	18	8.19	85.8	4.8	93,000	8.5	550	185	1.7	0.050	0.013	0.130	-
	"	8:58 A May 25	-	17	7.77	79.8	2.4	9,300	7.7	550	130	0.1	-	-	-	-
	"	7:52 A June 7	1,400	20	7.09	77.3	2.6	39,000	8.1	240	150	0.3	0.070	0.008	0.500	-
	"	2:10 P June 16	1,500	21	7.06	78.6	6.6	23,000	7.8	450	166	1.7	-	-	-	-
	"	9:21 A June 21	1,100	20	7.22	78.7	6.0	240,000	7.8	800	196	1.3	0.135	0.008	0.650	-
	"	8:41 A June 28	600	22	6.78	76.8	5.9	75,000	8.3	250	196	1.1	0.250	0.001	0.060	-
Union Creek	E - 128.7 Un.C. - 18.3	5:58 A Apr. 27	-	16	6.85	68.8	6.3	46,000	8.1	95	313	5.7	0.200	0.020	0.500	-
Bridge - 2 1/2 miles east of Madison	"	12:10 P May 2	-	16	10.12	101.8	5.4	23,000	8.2	40	320	6.2	0.230	0.008	0.600	-
	"	11:55 A May 6	-	16	7.18	78.4	4.5	39,000	8.1	90	326	5.1	0.310	0.035	0.500	-
	"	11:48 A May 12	-	20	6.74	73.5	4.6	23,000	8.2	80	328	5.1	0.330	0.037	0.700	-
	"	10:03 A May 18	-	18	5.95	62.4	3.9	43,000	8.3	110	326	4.9	0.370	0.075	0.680	-
	"	11:37 A May 25	-	17	7.47	76.7	4.2	150,000	7.8	1,500	235	3.4	-	-	-	-
	"	11:59 A June 1	-	19	5.85	62.6	3.7	43,000	8.3	110	256	3.3	0.065	0.006	0.200	-
	"	10:28 A June 7	-	18	6.66	69.9	3.4	15,000	7.9	320	295	5.2	0.320	0.022	2.222	-
	"	3:51 P June 16	-	20	6.49	70.7	5.7	15,000	7.7	550	272	5.1	-	-	-	-
	"	12:07 P June 21	-	18	4.92	51.6	4.1	460,000	7.3	11,000	98	0.9	0.350	0.010	8.520	-
North Branch Elkhorn River	E - 139.1 N.B.E. - 0.7	9:42 A May 18	-	19	7.04	75.2	1.4	9,300	8.3	75	226	2.3	0.090	0.050	0.500	-
Bridge - 1 mile south and 2 miles east of Norfolk	"	9:51 A May 25	-	18	7.59	79.5	4.0	9,300	7.7	450	136	0.3	-	-	-	-
	"	10:52 A June 1	-	18	7.08	74.2	2.3	24,000	7.7	100	246	3.0	0.050	0.005	0.450	-
	"	8:24 A June 7	-	20	6.99	76.2	1.5	24,000	8.1	45	188	2.8	0.240	0.038	0.600	-
	"	1:43 P June 16	-	22	6.66	75.4	>6.7	24,000	7.5	370	170	4.3	-	-	-	-
	"	9:58 A June 21	-	21	6.67	74.3	5.8	93,000	8.7	140	234	3.9	0.195	0.013	0.550	-
	"	7:56 A June 28	-	20	6.24	68.0	2.1	15,000	7.9	140	210	1.8	0.850	0.010	0.050	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1949	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen		5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m.			PO_4
					p.p.m.	% Sat.							NH_3	NO_2	NO_3	
North Branch Elkhorn River	E - 139.1 N.B.E.- 5.2	1:22 P Apr. 26	-	17	8.22	84.4	2.2	2,300	8.3	100	224	3.6	0.110	0.032	0.700	-
Bridge at the northeast edge of	"	11:06 A May 2	-	15	8.97	88.3	1.8	4,300	8.3	45	261	3.0	<0.040	0.012	0.700	-
Norfolk	"	10:19 A May 6	-	15	8.07	81.1	3.1	930	8.3	45	216	2.4	0.080	0.040	1.300	-
	"	8:35 A May 12	-	17	7.57	77.8	1.5	430	8.2	50	216	2.0	0.050	0.014	1.300	-
	"	10:37 A May 18	190	20	7.70	84.0	1.3	11,000	8.3	110	224	2.4	0.110	0.055	0.500	-
	"	10:19 A May 25	-	17	6.82	70.1	3.3	9,300	7.7	450	138	0.1	-	-	-	-
	"	10:37 A June 1	-	18	6.71	70.4	1.6	9,300	7.9	110	244	<0.1	0.065	0.007	0.550	-
	"	8:52 A June 7	-	19	7.01	75.0	1.2	9,300	8.1	55	240	2.6	<0.040	0.041	1.200	-
	"	1:25 P June 16	190	22	6.60	74.7	>6.6	46,000	7.5	370	173	5.4	-	-	-	-
	"	10:32 A June 21	-	20	6.61	72.1	5.2	9,300	8.7	160	238	4.4	0.195	0.018	0.450	-
	"	7:24 A June 28	120	19	6.19	66.1	2.5	15,000	8.4	140	214	1.1	0.850	0.012	0.060	-
Elkhorn River	E - 139.7	3:30 P Apr. 26	-	20	8.01	87.4	3.7	24,000	8.4	130	167	1.7	0.080	0.002	0.190	-
County Bridge - 2 1/2 miles south-	"	10:30 A May 2	-	15	9.42	92.7	3.3	93,000	8.4	90	172	1.4	<0.040	<0.001	0.050	-
east of Norfolk	"	10:45 A May 6	-	16	9.03	93.3	4.3	23,000	8.4	60	173	2.7	<0.040	<0.001	0.050	-
	"	10:55 A May 12	-	20	9.43	102.7	6.0	21,000	8.6	75	168	3.0	<0.040	0.003	0.080	-
	"	9:56 A May 18	-	19	9.31	99.6	5.2	9,300	8.7	70	166	1.7	<0.040	<0.001	<0.020	-
Elkhorn River	E - 141.3	4:00 P Apr. 26	922	19	8.21	87.8	1.8	4,300	8.4	110	170	1.4	<0.040	0.001	0.130	-
Bridge - U. S. Highway #81 -	"	11:40 A May 2	677	16	9.58	96.3	4.0	930	8.4	75	168	1.7	0.040	<0.001	0.090	-
1 1/2 mile south of Norfolk	"	11:20 A May 6	677	17	9.35	92.6	3.5	2,300	8.5	45	174	1.3	<0.040	<0.001	0.040	-
	"	11:16 A May 12	671	21	9.68	107.7	4.0	2,300	8.6	75	168	0.9	<0.040	0.003	0.060	-
	"	11:09 A May 18	500	18	9.79	102.5	6.4	3,900	8.7	75	166	1.0	<0.040	<0.001	0.050	-
	"	10:41 A May 25	1,670	18	7.89	82.7	2.9	3,900	7.9	270	126	< 0.1	-	-	-	-
	"	10:07 A June 1	2,030	19	7.00	74.9	2.2	2,100	7.9	200	156	< 0.1	0.043	0.002	0.030	-
	"	9:20 A June 7	870	19	7.69	82.2	1.9	2,300	8.1	100	174	0.3	0.050	0.003	0.220	-
	"	3:16 P June 16	700	22	7.88	90.4	7.0	2,300	7.9	200	168	2.1	-	-	-	-
	"	11:04 A June 21	480	21	8.08	89.9	>8.1	4,300	8.2	150	182	0.4	0.058	0.012	0.075	-
	"	6:50 A June 28	360	20	7.11	77.5	3.6	9,300	8.4	150	171	0.7	0.035	0.001	0.020	-
Elkhorn River	E - 187.7	11:46 A Apr. 26	656	18	8.10	84.9	0.7	430	8.2	35	156	1.8	0.060	0.001	0.150	-
Bridge - Highway #14 south edge of	"	8:52 A May 6	374	14	8.83	86.0	1.8	930	8.3	30	142	0.3	0.040	-	-	-
Neligh	"	7:33 A May 12	350	17	7.85	80.6	1.9	430	8.2	50	142	0.2	-	-	-	-
	"	8:45 A May 18	270	18	8.58	89.9	3.4	93	8.5	10	146	0.6	<0.040	0.001	0.040	-
	"	8:48 A June 1	1,360	18	6.80	71.3	3.2	430	7.8	80	149	0.4	0.041	0.004	0.030	-
	"	11:31 A June 9	550	19	7.51	80.4	1.2	930	8.5	50	204	0.1	0.140	0.001	0.650	-
	"	12:26 P June 16	490	21	7.36	81.9	>7.4	4,300	7.9	60	152	0.3	-	-	-	-
	"	10:20 A June 21	273	20	7.61	83.0	5.3	24,000	8.3	75	181	<0.1	-	-	-	-
	"	5:39 A June 28	178	21	6.58	73.2	3.7	2,100	8.4	60	136	0.4	0.055	<0.001	<0.020	-
Clearwater Creek	E - 199.5 Cl.C.- 3.6	11:08 A Apr. 26	46	17	8.85	90.9	1.0	91	8.3	9	180	1.1	<0.040	0.003	0.130	-
Bridge - 1/2 mile west and 2 miles	"	8:25 A May 6	36	12	9.32	85.6	1.4	430	8.3	2	180	0.6	<0.040	-	-	-
south of Clearwater	"	6:41 A May 12	40	15	7.98	78.5	1.8	930	8.1	10	176	0.4	-	-	-	-
	"	7:53 A May 18	36	16	8.43	84.7	1.6	1,500	8.3	15	181	0.2	0.040	0.006	0.160	-
	"	8:19 A June 1	100	17	7.00	71.9	1.9	4,300	7.8	20	190	<0.1	0.065	0.004	0.030	-

LOWER PLATTE RIVER BASIN WATER POLLUTION INVESTIGATION
LABORATORY DATA

SUMMARY OF INDIVIDUAL RESULTS

Sampling Point	Mileage from Mouth	Date 1969	Avg. disch. c.f.s.	Temp. °C	Dissolved Oxygen p.p.m.	Dissolved Oxygen % Sat.	5-Day B.O.D. p.p.m.	Coliforms M.P.N. Per 100 ml.	pH	Turb. p.p.m.	Alkal. p.p.m.	Cl. p.p.m.	Nitrogen - N p.p.m. NH_3	Nitrogen - N p.p.m. NO_2	Nitrogen - N p.p.m. NO_3	PO_4
Clearwater Creek	E - 199.5 Cl.C.- 3.6	10:46 A June 9	70	20	7.71	84.1	4.6	2,300	8.4	60	180	< 0.1	0.150	0.001	0.600	-
Bridge - 1/2 mile west and 2 miles	"	11:31 A June 16	67	20	7.21	78.6	6.2	1,500	7.7	65	192	0.3	-	-	-	-
south of Clearwater	"	9:40 A June 23	33	19	7.51	80.2	4.3	4,300	8.3	45	182	0.2	-	-	-	-
South Fork Elkhorn	E - 210.1 S.F.E.- 1.0	10:00 A Apr. 26	67	16	8.85	89.0	1.2	91	8.2	25	118	1.0	0.050	0.001	0.400	-
River County Bridge -	"	7:44 A May 6	60	12	9.82	91.1	2.4	230	8.3	35	109	< 0.1	<0.040	-	-	-
1/4 mile south of Ewing	"	5:58 A May 12	60	15	8.74	86.0	1.7	430	8.1	30	117	0.8	-	-	-	-
	"	7:14 A May 18	57	16	8.92	89.6	1.8	430	8.1	15	117	0.6	<0.040	0.003	0.450	-
	"	7:55 A June 1	189	18	7.14	74.8	1.8	750	7.8	20	159	0.4	0.065	0.009	0.070	-
	"	10:18 A June 9	95	19	7.82	83.6	1.1	430	8.4	40	133	< 0.1	0.135	0.001	0.850	-
	"	10:32 A June 16	92	20	7.19	78.4	5.0	930	7.9	40	134	0.6	-	-	-	-
	"	9:00 A June 23	52	20	7.64	83.2	6.3	750	8.3	30	115	0.7	-	-	-	-
Elkhorn River	E - 211.8	10:33 A Apr 26	355	16	7.97	80.2	1.4	150	7.9	10	144	2.6	0.120	<0.001	0.120	-
County Bridge - 1 1/2 miles north	"	7:50 A May 6	166	13	8.50	82.4	1.8	930	8.2	15	123	0.3	0.060	-	-	-
of Ewing	"	6:14 A May 12	150	15	7.61	75.0	1.3	390	8.2	15	119	0.3	-	-	-	-
	"	7:20 A May 18	123	16	8.29	83.3	3.4	390	8.4	10	122	0.3	0.040	0.004	0.050	-
	"	7:33 A June 1	1,020	17	5.78	59.4	2.0	1,500	7.7	20	144	0.3	0.055	0.008	0.065	-
	"	10:00 A June 9	285	19	7.10	76.0	1.3	4,300	8.4	65	150	<0.1	0.185	<0.001	0.600	-
	"	10:11 A June 16	213	21	7.01	78.0	5.4	930	7.7	45	139	0.4	-	-	-	-
	"	8:30 A June 23	112	21	7.54	83.9	7.1	930	7.8	60	128	0.3	-	-	-	-
Elkhorn River	E - 233.6	9:06 A Apr. 26	-	15	7.69	75.7	1.3	230	7.9	8	142	0.9	0.130	<0.001	0.150	-
Bridge - U. S. Highway #275 -	"	7:05 A May 6	-	13	7.92	79.7	1.7	>11,000	7.8	8	128	<0.1	0.100	-	-	-
4 1/2 miles southeast of	"	5:20 A May 12	-	16	6.82	68.5	2.1	23,000	7.9	3	120	0.5	-	-	-	-
O'Neill	"	6:36 A May 18	-	16	6.92	69.6	2.5	93,000	7.7	7	113	0.2	0.050	0.009	0.500	-
	"	6:58 A June 1	-	18	5.47	57.3	2.5	910	7.7	15	150	0.3	0.090	0.010	0.075	-
	"	9:26 A June 9	-	19	6.81	72.9	1.6	23,000	8.4	75	144	<0.1	0.180	<0.001	0.600	-
	"	9:21 A June 16	-	20	7.31	79.6	6.2	2,300	7.6	45	136	1.0	-	-	-	-
	"	7:49 A June 23	-	21	7.38	82.2	-	2,300	7.7	55	128	0.3	-	-	-	-
Elkhorn River	E - 236.1	8:43 A Apr. 26	-	15	7.69	75.7	1.3	4,300	7.9	3	137	0.6	0.130	<0.001	0.160	-
Bridge - U. S. Highway #281 -	"	6:46 A May 6	-	13	7.83	76.5	2.1	430	7.7	7	124	< 0.1	0.080	-	-	-
1/2 mile south of O'Neill	"	5:05 A May 12	-	16	7.34	73.7	1.4	430	7.9	10	116	< 0.1	-	-	-	-
	"	6:20 A May 18	-	17	7.30	75.0	1.8	280	7.8	15	110	< 0.1	0.040	0.008	0.650	-
	"	6:32 A June 1	-	18	5.20	54.5	1.7	930	7.7	10	154	0.4	<0.040	0.009	0.075	-
	"	9:05 A June 9	-	18	7.11	74.6	2.1	4,300	8.4	70	143	0.3	0.175	0.001	1.500	-
	"	8:42 A June 16	-	20	7.20	79.4	5.8	2,300	7.6	40	140	1.0	-	-	-	-
	"	7:16 A June 23	-	20	7.46	81.3	6.8	1,500	7.7	50	126	0.8	-	-	-	-